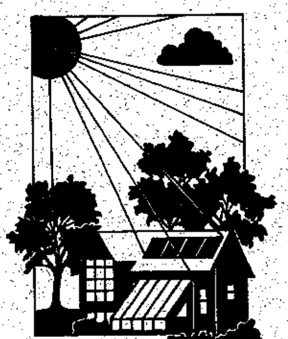
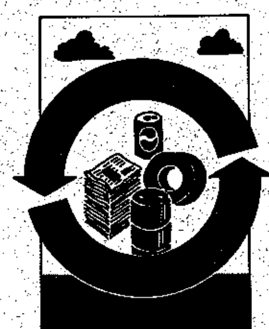



Energy and Economics

An Activities Book






By
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and
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Nebraska Council on Economic Education
with
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TO THE INSTRUCTOR

The Office of Energy and Economic Education works with teachers and schools to improve understanding and awareness of the energy issues in Nebraska. Our citizens need to be informed about our energy resource problems and their economic effect on schools and communities. Educational materials, films, curricula, teaching activities, and workshops are available to Nebraska teachers to promote better understanding of the economics of energy.

"Energy and Economics Activities Book" is a unit which introduces students to the topic of energy from an economic perspective.

This unit consists of eleven individual lesson plans which incorporate such economic concepts as supply, demand, equilibrium, scarcity and cartels in the energy marketplace. It contains worksheets and simulation games with teacher background material to help teach the interrelationships between energy and economics.

The Office of Energy and Economic Education offers other curriculum guides on energy as well as the following:

- Workshops on teaching about energy choices
- Resource library of energy education materials
- Free-loan of energy films and videotapes
- Free assistance with curriculum development.

The Office of Energy and Economic Education is sponsored by a grant from the Nebraska Energy Office to the Nebraska Council on Economic Education. The Office is located at the 501 Building, Room #1, 501 North Tenth Street, University of Nebraska-Lincoln. For further information contact: JoAnn McManus, Telephone (402) 472-5612/2333. You are encouraged to use the ordering pages attached to this unit.

CONCEPT GRID

ACTIVITY	1	2	3	4	5	6	7	8	9	10	11
Economic Concepts											
Decision Making	•		•	•		•	•				
Externalities	•						•				•
Limited Choices		•									
Demand		•							•	•	•
Scarcity		•	•	•	•			•			
Trade-Offs		•	•	•	•		•		•		
Opportunity Costs		•	•	•	•		•		•		
Investment			•								
Savings				•							
Specialization				•				•			
Energy Concepts											
Resource Conservation	•	•	•	•	•	•	•	•	•	•	
Heating Fuels		•							•		
Energy Alternatives		•					•				
Energy Management			•								
Energy Resources			•				•	•	•		
Energy Awareness				•		•		•	•	•	•

PROPOSED STRATEGY GRID

ACTIVITY	1	2	3	4	5	6	7	8	9	10	11
Strategy											
Films	•	•	•	•		•	•		•	•	•
Guest Speakers	•	•	•	•	•	•	•	•	•	•	
Field Trips	•						•		•	•	•
Lecture	•	•	•	•	•	•	•	•	•	•	•
Research	•	•	•	•		•	•	•		•	
Demonstration	•			•			•		•		
Simulation	•						•		•		
Group Work		•						•			
Application Activity		•	•	•	•	•	•	•		•	

ACTIVITY #1 TREES FOR ENERGY

GRADE LEVEL

Upper Elementary, Middle Grades, High School.

TIME REQUIRED

3 - 5 Class periods (50 minutes)

RATIONALE

Trees add to energy savings and conservation value by shading in summer and creating a windbreak in the winter. One can maximize the energy savings of a landscape planting with proper design and maintenance plans. These plans influence the amount of energy required for mowing, watering, weeding, fertilizing, and chemical pest control.

There is a beautifying effect of green growing trees in the spring and summer, and colorful pageantry in the fall. The community reaps benefits of trees around the school through the savings of energy dollars through energy management with trees.

Trees have long-term economic and environmental effects. The trees, a community benefits from today, were planted years ago. Student participation in landscape planning and planting around the school or other buildings will increase awareness of their role in present as well as future energy conservation.

OBJECTIVES

1) Students will use an economic decision-making grid to determine which trees will contribute to an energy-efficient building.
2) Students will list desirable criteria used in plant selection.
3) Students will use information available from the library and community sources for use in plant selections.
4) Students will chart the positive and negative externalities of tree planting.
5) Students will research and write about various opportunities and careers involved in forestry, horticulture, etc.

CONCEPTS

Decision-making, resource conservation, externalities.

STRATEGIES

Films, guest speakers, field trip to an arboretum, lecture, research, demonstration, and simulation.

BACKGROUND LESSONS AND EXERCISES

In order for students to understand the value and variations of shade trees to a school and community, three preliminary activities are necessary. It is important that the concepts underlying planting design are understood, so the design accomplishes the goal set forth. These activities are also necessary as preliminary background information because they will demonstrate the need for correct design.

Exercise I: EXTERNALITIES

THIRD-PARTY COSTS AND BENEFITS[1]

Third-party costs and benefits—or externalities—are the effects of production or consumption of a good or service on people (the third parties) who are not directly involved in the transaction.

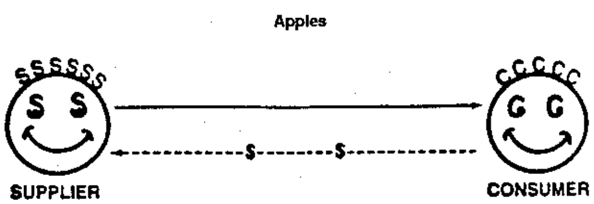
To understand externalities, let's first look at a transaction that has none. Figure 1 shows the market interaction between a supplier and a consumer of a good. Let's say they are producing and consuming organically grown apples. The supplier is one of several producers of apples, and the consumer is one of many consumers of apples. In the transaction, our apple eater receives the apples and in turn pays the farmer, as indicated by the lines. The supplier has absorbed many costs of production but is satisfied with the transaction because of the payment received from the consumer. The consumer is happy with the transaction because of the benefit derived from eating the apples. In such transactions, the producers and consumers bear all the costs and benefits. Suppliers pay all the costs of production; no one else bears any costs or receives any benefits from the production. Consumers receive the benefit of consumption; their consumption brings no costs or benefits to others.

Organically grown apples are used in the transaction described above because real-world examples of products free from external benefits and costs are hard to find. If the apple farmer had used fertilizer and pesticide, many other people might have been affected. What might some of these effects have been?

External costs and external benefits are directly opposite to each other. If the external effect is negative, it is called a **negative externality** or an **external cost**. If the external effect is beneficial, it is called a **positive externality** or an **external benefit**.

Figure 1

Private Transaction of a Good

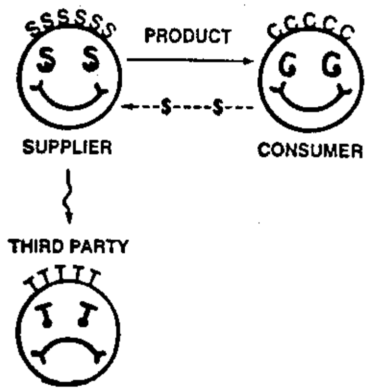


We'll use Happy Faces and Sad Faces to illustrate third-party costs and benefits. Each illustration in Part A and Part B shows a supplier, a consumer, and a third party. The suppliers have S's for hair, the consumers C's, and the third parties T's.

Part A depicts an external cost of production. The seller and consumer have happy faces. The consumer receives the product and pays the seller. Because this is a voluntary transaction, the consumer thinks the payment for the product is worthwhile.

Part A

External Costs of Production



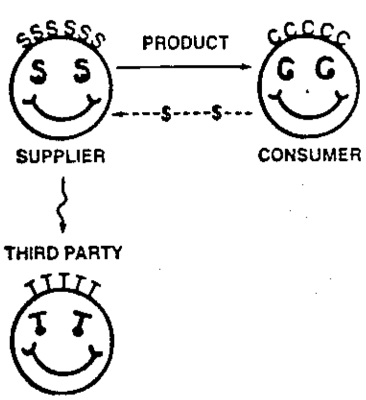
The seller also has a happy face since the payment provides an acceptable price for the product. However, Part A shows a third party who is sad because of a negative effect from production. An example of an external cost of production is pollution resulting from a manufacturing process. Let us suppose that in Part A the producer's operations pollute air or water and the producer does not prevent the pollution or clean it up afterward. Hence, the producer's price does not include the cost of dealing with the pollution. The consumer also benefits because if the producer does not have to cover the cost of dealing with the pollution, the price to the consumer is lower that it otherwise would be. However, third parties or other people who must now contend with dirtier air or more polluted water suffer increased costs such as health problems, reduced recreational opportunities, and high taxes for water purification. Because the price of the product is lower than it would be if the producer paid all the costs of dealing with the pollution, the unregulated market economy will produce too much of the product. In general, because third-party costs are not reflected in the market prices paid by buyers, goods or services that result in external costs will be overproduced in an unregulated market.

1 Adapted from an exercise developed by John Pisciotta, Stevens Professor of Private Enterprise, Baylor University.

Part B depicts an external benefit of production. The external benefit again comes from a market transaction, but this time it brings a happy face to the third party, for in this instance, third parties benefit even though they pay none of the costs of producing the product. An example is a dam built to generate electric power. Among the third-party benefits might be flood control for downstream residents and a lake for recreation. People whose homes are no longer subject to floods or those who fish, swim, and go boating in the lake would also benefit from the dam. However, in the absence of a subsidy or other nonmarket means of reducing producer costs, goods with external benefits tend to be underproduced in an unregulated market. Thus, if the dam must be paid for from electricity charges only, it might not be built, because the electricity charge alone may not be sufficient to permit the dam to operate at a profit.

Part B

External Benefits of Production



Because an unregulated market overproduces products with external costs and underproduces products with external benefits, government may intervene to correct these situations. For instance, the government sometimes takes action designed to raise the price of products that impose external costs. It can require firms to meet certain pollution standards. This increases costs of production, decreases supply and raises the equilibrium price. Less of the product will be produced than in an unregulated market. There also will be less pollution. The government sometimes encourages the production of products with external benefits and subsidies. If the government finances part of the cost of a hydroelectric dam, the dam may become practical to build. If the power company had to pay all the costs, it might not build the dam: consumer demand for a recreational lake is not reflected in the demand for electricity. Private market decisions that are motivated by self-interest tend to ignore external costs and benefits. In those situations, a case may be made for government intervention.

1. List the positive and negative externalities of planting and maintaining the planted tree.

POSITIVE	NEGATIVE
energy saved	energy of watering, fertilizing
beautification	chemical pest control
mulching	weeding, trimming
science class usage	maintenance

2. Complete Worksheet for Exercise I, Externalities

Worksheet for Exercise I
EXTERNALITIES [2]

NAME ______________________________ CLASS ______________________________

1. Define negative externality or third-party cost.

____

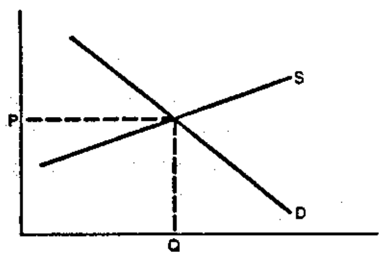
2. Give three examples of third-party costs.

____

____

____

3. In the supply and demand graph below, only the private costs and benefits have been accounted for. Draw the new supply curve, and show the new equilibrium price and quantity for steel if the external costs of pollution were also counted as costs of production.



Tons of Steel

4. Would more or less steel be produced according to the new supply curve?

____

5. Would the price be higher or lower?

____

6. Why are products that entail third-party costs "over-produced"?

____

____

____

7. Define positive externality or third-party benefit.

____

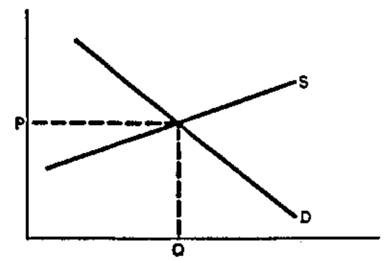
8. Give three examples of third-party benefits.

____

____

____

9. In the supply and demand graph below, only the private costs and benefits have been accounted for. Change the graph to show the new equilibrium if all the third-party benefits to the community were counted as part of demand. Show the new equilibrium price and quantity.



Education

10. Would more or less energy be available according to the demand curves?

____

11. Would the price be higher or lower?

____

12. Why may products that yield third-party benefits be "underproduced"?

____

____

____

2 From Master Curriculum Guide in Economics: Teaching Strategies for High School Economics Courses. 1985. Joint Council on Economics Education, 432 Park Avenue, New York, NY 10016.

Exercise II: DEMONSTRATION OF THE VALUE OF SHADE

1) Students will monitor the temperature of two settings.
2) Students will monitor and compare the difference between the setting with sun and the setting without the sun.
3) Students will be prepared to discuss that as more sun comes into the room, there is more heat gain demonstrating the sun's value in the winter months; and as less sun comes into the room, there is less heat gain and the value of shade trees in summer months.

Exercise III: DETERMINE THE EFFECT OF SHADE AND TREE SHADOWS ON BUILDINGS

1) A flashlight will be used to simulate the sun.
2) Students will draw to scale various shade trees.
3) Students will cast shadows at different heights of sun, simulating different seasons.
4) Students will determine how different trees have different shade patterns.
5) Students will discuss how the placement of trees affects whether a building is shaded or not, and whether or not benefits of energy savings are present.
6) Use Worksheet for Exercise III, Shade and Shadows.

Worksheet for Excercise III SHADE AND SHADOWS[3]

MATERIALS

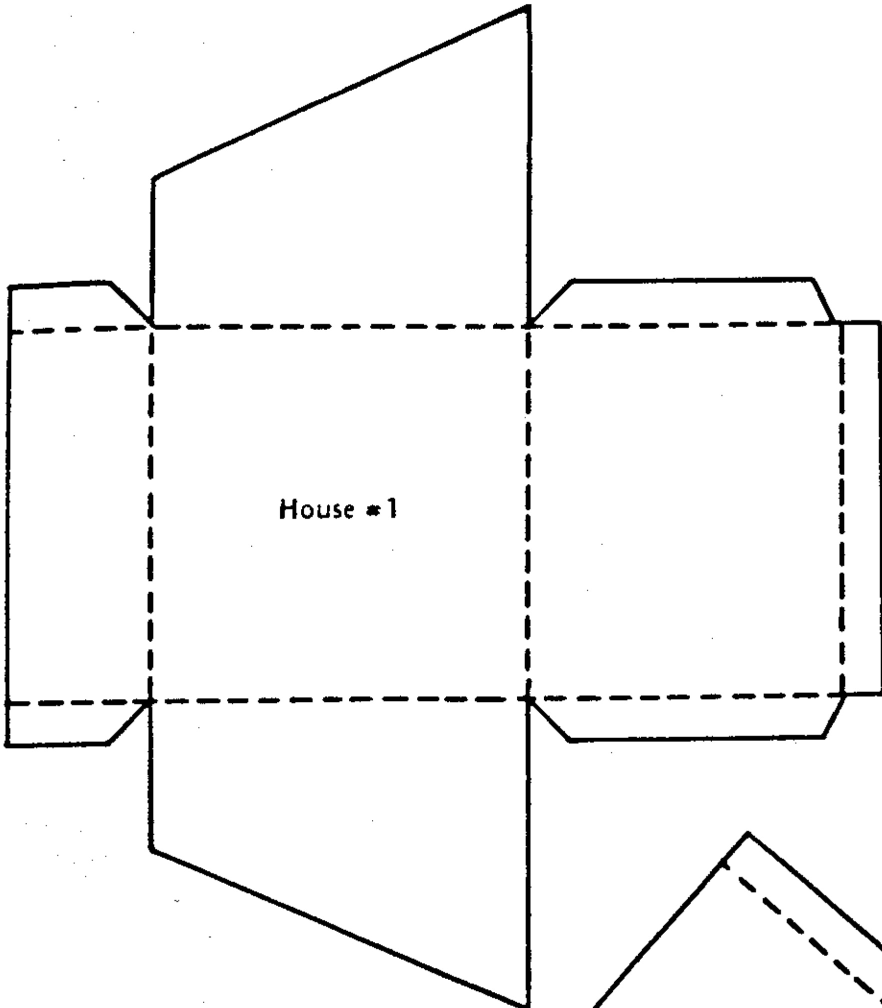
- Scissors
- Tape
- Toothpicks
- Straight edge
- Worksheets for Exercise III: Model Houses, Plot Plan and Model Trees and Shrubs
- A light source (flashlight, lamp)
- Crayons or markers (optional)

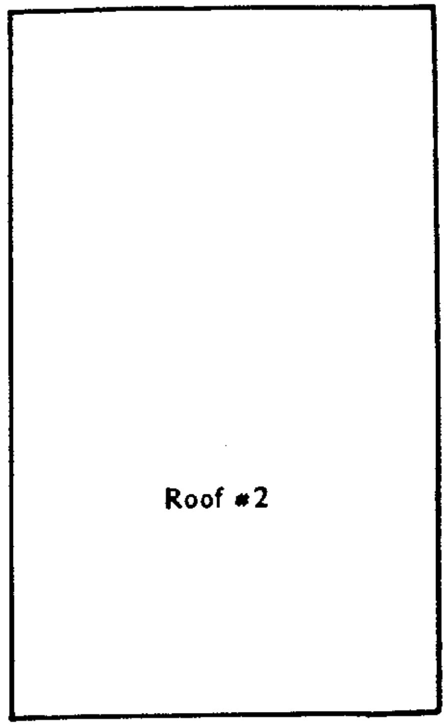
PROCEDURE

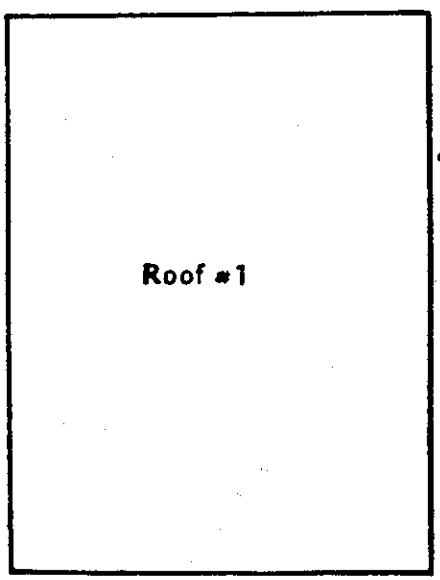
1. Select one model from the two model house drawings on the Worksheet for Exercise III. Cut out, fold, and assemble (without taping) the model you chose.
2. Place the folded model house on the Worksheet for Exercise III Plot Plan and decide on the setting of the dwelling. In which direction will it face? Decide how many windows and doors your house should have.
3. Choose the locations based on the setting of the house. Then unfold the model and draw in the windows and doors neatly with a pencil and straight edge. Color the house if you wish. Refold and tape the model together. Then tape the roof in place. Place the completed house on the plot plan.
4. Find out the directions of the winter winds and summer breezes in your area. Draw arrows in the proper corners of your plot plan to indicate these directions. Label each arrow.
5. Draw in fencing (if any), driveway, and sidewalks. Can you place these features to provide protection from winter winds?
6. Cut out the Model Trees and Shrubs from the Work sheet for Exercise III and use them to trace out as many additional trees and shrubs as you want to use in landscaping. Cut these out and fold their bases. For added strength, tape toothpicks to the backs of the trees. Keep in mind that deciduous trees lose their leaves in fall and that winter winds and summer breezes come mostly from one direction. Plan how you will landscape the plot, then tape the summer deciduous models in place. Tape all other models in place.
7. Find out the noontime angle of the sun in your area for winter and for summer. Set the light source at the noontime angle for the summer sun. Check your house and landscaping for the effectiveness of summer shading. How many windows receive direct summer sunlight? Do your deciduous trees shade the house to help keep it cool? Does your roof overhang provide shading from the summer sun? Does your landscaping channel cooling summer breezes toward your house?
8. Now fold down your summer tree models so that the winter models are visible. Set the light source at the noontime angle for the winter sun. Again check your house and landscaping, this time for the effectiveness of winter solar heating. How many windows receive direct winter sunlight? Do any trees block the sun's rays, preventing them from warming the house? Does the roof overhang allow the winter sunlight to pass through your windows? Do your evergreen trees break and slow those cold winter winds?

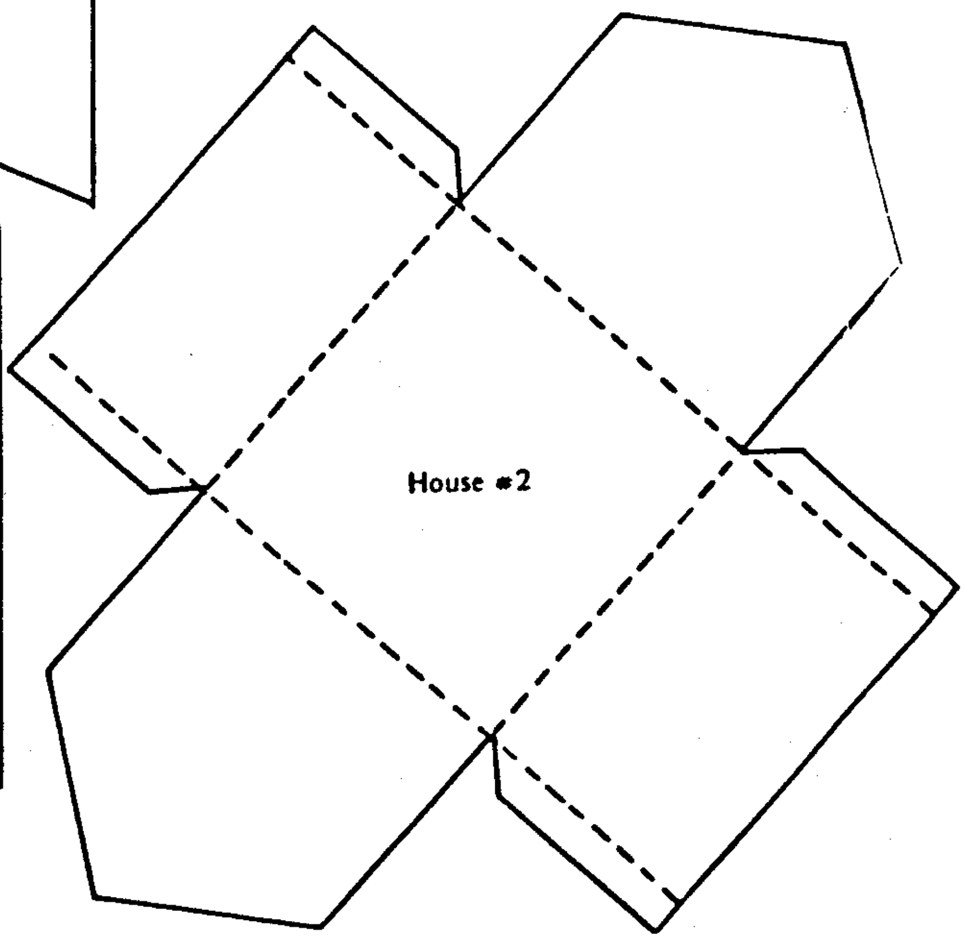
3. Student Activities from New York Education Project, 1400 Washington Avenue, Box 22100, Albany, NY 12222.

Worksheet for Exercise III
MODEL HOUSES

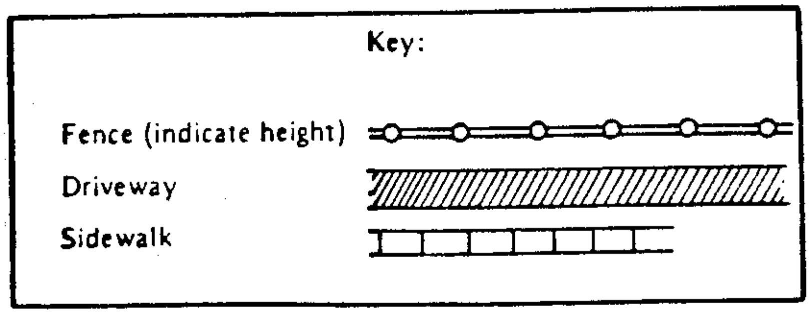


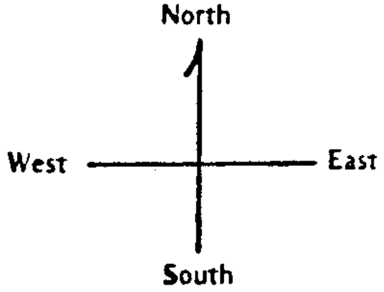




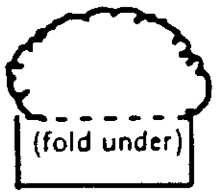


Worksheet for Excercise III
PLOT PLAN

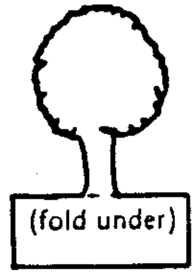




Worksheet for Exercise III
MODEL TREES AND SHRUBS

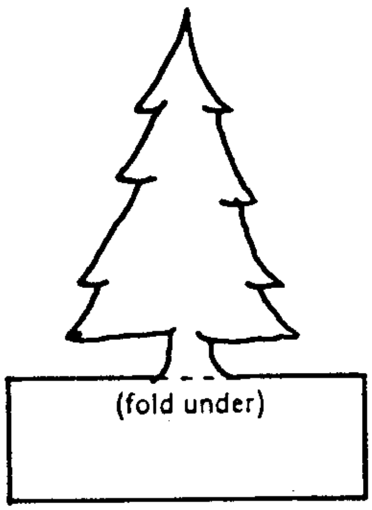


Shrub

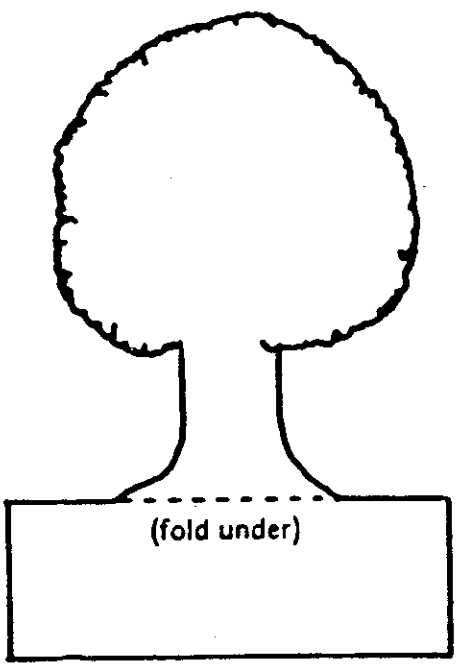


Small Deciduous Tree, Summer

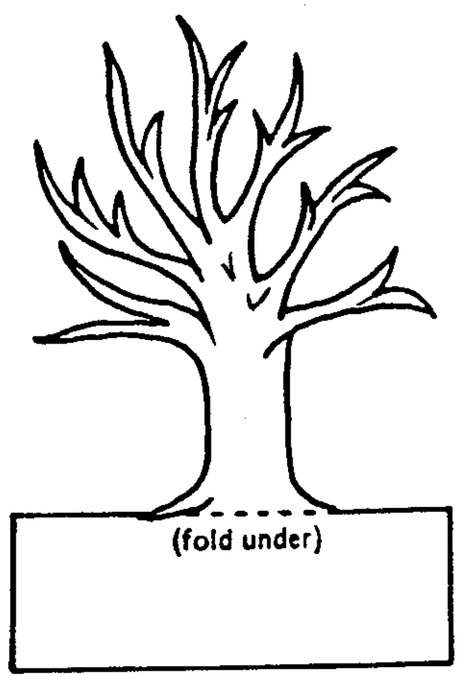
Small Deciduous Tree, Winter



Evergreen



Large Deciduous Tree, Summer



Large Deciduous Tree, Winter

Model House Questions

1. How does your model house compare to those of other students in placement of windows, size of doors, and roof arrangement?
2. Which model house from the Worksheet for Exercise III is best designed for winter heating and summer cooling? Why?
3. Now that you have completed the activity, how could you improve your model house and landscaping to increase their effectiveness in winter heating and summer cooling?
4. A passive solar house such as you have constructed is considered one way to conserve energy. Why?
5. How should homes be landscaped to conserve energy?
6. In which direction should the roof overhang face so that winter sunlight passes through windows and summer sunlight is blocked out?
7. Define the following terms: deciduous tree, evergreen tree, roof overhang, passive solar house.

LOOKING BACK

You have now planned the design and landscaping of a passive solar house. In doing this you may have discovered that there are many simple things you can do to use the sun's heat in cold weather and still avoid overheating in summer.

Did you consider which way the house should face? How many windows and doors did you plan, and where did you put them? Did you use roof overhangs for summer shade? What about evergreen windbreaks and deciduous shade trees? A passive solar house uses all these features to save energy by natural heating and cooling.

GOING FURTHER

Make the improvements to the model house that you suggested in your response to Model House Question 3. Add a sunspace or solar greenhouse to your model house. Indicate an earth berm on the proper side(s).

Make additional copies of Worksheets for Exercise III Models Houses, Plot Plan and Model Trees and Shrubs. Redesign and landscape the same house for an active solar energy heating or hot water system. Draw flat plate solar collectors on the south-facing roof. Determine the best roof pitch for the collectors and redraw the sidewalls to obtain this pitch.

Make additional copies of Worksheets for Exercise III Model Houses, Plot Plan and Model Trees and Shrubs. Redesign the same house to include a cooling system, such as an evaporative cooling system. What factors will have to be considered for such a system?

Construct a passive solar model home of your own design from other materials, such as wood or plaster of paris.

Energy Classroom Activity III a: DESIGNING PLANTING FOR SHADE

1) Identify a project location. Which site needs shade around the school?
2) Evaluate the site.
   a) Is the size of the space adequate?
   b) What is the location of the underground utilities and overhead powerlines?
   c) What is the site's aesthetic qualities?
   d) Is the site suitable for planting — is the soil of good quality and is water available?
3) Apply the decision-making grid.
   a) Define the problem.
   b) Determine the criteria for plantings based on shading and other plant characteristics, i.e. height, deciduous versus evergreen, hard versus soft wood, lifespan, insect and disease problems, adaptability, and cost.
   c) List alternatives, such as various types of shade trees.
   d) Evaluate the alternatives.
   e) Make the decision.
4) Planting
   a) Consult with local nursery person, garden club members, Cooperative Extension Service, Natural Resource District, and/or Soil Conservation Service for additional information and for the proper methods of planting.
5) Maintenance
   a) Students will be designated as caretakers for year-around maintenance.
   b) There are two primary kinds of maintenance: watering and weeding.
      1) Watering
         a) Initially in spring, water at planting time thoroughly.
         b) Follow this procedure by watering every 10 days to two weeks, if no rain.

c) During the first year, no fertilizer is generally needed.
2) Weeding
   a) Select a mulching material that will help conserve water and reduce weeding.
   b) If no mulching
      1) Control weeds before they become large.
      2) Weed on regular basis, before watering.
      3) Cut or trim weeds rather than pull weeds during first year so as not to disturb root system.

SUPPLEMENTARY ACTIVITY CAREERS

Allow students time to research careers in forestry, horticulture, etc. and to make oral reports to the class on their research.

ACTIVITY #2 A COMMUNITY ENERGY SURVEY

GRADE LEVEL

Upper Elementary, Middle Grades, High School

TIME REQUIRED

3 - 5 Class periods (50 Minutes)

RATIONALE

The homeowner with flexible choices (alternatives) in heating fuels can resist price increases in one fuel by choosing another as a substitute. The homeowner dependent upon one fuel must find ways to conserve energy. Fuels are scarce and limited. The wise consumer chooses carefully. Using one fuel over another can involve environmental trade-offs, such as social costs in air and water pollution, acid rain, and/or stripping the land. Through this exercise, students should be able to explain the pattern of fuel use in their community.

OBJECTIVES

1) The student should be able to design an energy questionnaire.
2) The student should be able to conduct an energy survey, tabulate data, analyze the data, and make recommendations.
3) The student should be able to explain which fuel users in the community have the most flexibility in fuel use.
4) The student will explore options for each fuel source surveyed.

CONCEPTS

Limited choices, demand, scarcity, trade-offs, heating fuels (wood, electricity, coal, gas, oil, solar), energy alternatives, energy conservation and opportunity cost.

STRATEGIES

Lecture, research, films, guest speakers, group work and application activity.

Exercise I: OPPORTUNITY COST

Opportunity Cost and Energy [1]

An important idea used in analyzing economic problems is the concept of opportunity cost defined as the "best alternative passed by" when a person makes a choice among several possible opportunities which would use the same resources. Because of the problem of scarcity, people cannot have everything they want or need. They must make choices. The best alternative that is given up when a choice is made represents the **opportunity cost** of that decision. Let's look at some examples to illustrate this point:

1) You may have two invitations to parties on Saturday night and you want to go to both. However, you can only accept one invitation. The **opportunity cost** of accepting one is the other party you give up.
2) A piece of land can be used for farming or for a park. It cannot be used for both. If it is used for a park, the **opportunity cost** is the crop that could be grown as well as the peaceful atmosphere that exists without campers and picnickers. If it is used for farming, the **opportunity cost** is the loss of recreational activities that could be enjoyed in the park.
3) You can attend a college after high school or go to work at your uncle's store. The cost of attending college includes the income you are giving up plus the money you must pay for tuition, books, etc. The **opportunity cost** is the other things you gave up by not having this money available.
4) When a city has vacant land that can be used for housing or a parking lot, what are the opportunity costs involved in deciding on one or the other?
5) What about energy? What opportunity costs are involved in your driving to the store rather than walking? In leaving the lights on in a room that no one is using?

As consumers and citizens, we should consider the **opportunity costs** of our decisions. Remember, the dollar cost alone probably does not measure the **opportunity cost** of each choice. What is the best choice to make? We should choose the alternative that provides enough satisfaction to override the "costs" of the best alternative that was given up.

People may look at the same choice and make very different decisions because opportunity costs will differ depending on their beliefs, ages, personal circumstances, etc. The following worksheet will help you understand that problem and give insight into why energy production and use is such a controversial issue.

1 This activity is based on a lesson in **Energy Trade-offs in the Marketplace**, a unit developed jointly by the Washington State Superintendent of Public Instruction Office and the Washington State Council on Economic Education (Seattle: 1980).

Worksheet for Exercise I
OPPORTUNITY COST

You must vote "for" or "against" a suggested public transportation proposal using your decision-making skills and applying the idea of opportunity cost. Pretend you are in the following roles and decide how each person should vote on the following recommendation:

Your town, Squaresville, will purchase and operate a small bus between Squaresville and a larger city, Rocktown, 20 miles away. Many people in Squaresville work and shop in Rocktown. The bus would make two round-trips each day: one bus is scheduled to meet working hours of 8:00 a.m. to 5:00 p.m. in Rocktown, and the other bus goes at 10:00 a.m. and returns at 3:00 p.m. Bus tickets will cost about the same for one person as it would for that person to drive a mid-size car. Local taxes will be increased by about 3% to help pay for this bus. ($36 per year for the average homeowner.)

Role 1: Herman: 18 years old from Squaresville. Owns a used car. Works part-time (8:00 a.m. until noon) in a grocery in Rocktown.

Opportunity Cost "Yes" Vote:

Opportunity Cost "No" Vote:

Your Vote____________

Role 2: Mr. & Mrs. Snurd: Married couple. Young, no children, own a large home in Squaresville, and both work in Rocktown. Each drives own car to work. (Her job 8:00 a.m. to 3:00 p.m.; his job 9:00 a.m. to 5:00 p.m.). His job requires frequent use of car on 3 or 4 days each week.

Opportunity Cost of "Yes" Vote:

For Her:

For Him:

Opportunity Cost of "No" Vote:

For Her:

For Him:

His Vote ____________

Her Vote____________

Role 3: Joe Shmo: Forty years old from Squaresville. Family of four. Works in plant on bus route halfway to Rocktown. He drives the family's only car.

Opportunity Cost of "Yes" Vote:

Opportunity Cost of "No" Vote:

Your Vote____________

Role 4: Susan Sunshine: Eighteen years old, senior in Squaresville High School, hardly ever goes to Rocktown because she doesn't own a car.

Opportunity Cost of "Yes" Vote:

Opportunity Cost of "No" Vote:

Your Vote ____________

Role 5: The Oldey's, retired Squaresville couple with poor eyesight. Like to go to Rocktown, but driving is difficult in rainy or snowy weather.

Opportunity Cost of "Yes Vote:

Opportunity Cost of "No" Vote:

Your Vote ____________

Exercise II: THE ECONOMICS OF CONSERVATION

Demand is a relationship between quantity and price. Specifically, it is the amount of a good or service that a consumer is willing and able to purchase at various prices at any given time. It is an inverse relationship because at a lower price, higher quantities of a good or service will be purchased; and conversely, lower quantities at higher prices.

The concept of demand can be illustrated in the following activity. The students will examine the effects of changes in the price of heat energy on consumer behavior (changes in demand) by conducting a survey of home owners.

1. Every class member is to survey two home owners about the relationship between price and heat energy usage. Students should ask the following question: "If the price of heat energy were to go up _____ (read the amount) per unit, would you be likely to use as much as you do now or would you lower your thermostat 5 degrees or 10 degrees? Repeat the question four times, using .10, .50, $1.00, and $2.00, and record the responses on a table such as the one below. (Copy the table on the chalkboard.)

Increases in Price

Heat Energy	.10	.50	$1.00	$2.00
No Change				
down 5 degrees				
down 10 degrees				

2. Record the survey responses on the chalkboard and then discuss them, using the following questions as a guide:
   a. What was the relationship of heat energy use and price?
   b. What do you suppose would happen if the price of heat energy were to go down?
   c. Using the survey results as a guide, how much would the heat cost need to increase to reduce greatly the amount being used?
   d. The price of heat energy has increased substantially over the last few years. How are people coping with the increasing costs? Are they using weather-proofing, turning down the thermostat, etc.?

Exercise III: LAW OF DEMAND

To illustrate a demand schedule and the law of demand, put several possible gasoline prices on the board. For example:

Price/Gallon	Quantity per Week
$3.00	
2.00	
1.00	
.50	

Ask several of the students who drive to tell how much gasoline they would purchase per week at each price. Put this information in the quantity column. The resulting demand schedule should also illustrate the law of demand, because at a higher price ($3.00) students will generally purchase less gasoline per week than at a lower price ($.50).

Define "Demand" and the "Law of Demand." (Demand is a schedule which shows the various amounts of a product which consumers are willing and able to purchase at each specified price in a set of possible prices during some specified period of time. The Law of Demand is an inverse relationship between price and quantity demanded. As price falls, the corresponding quantity demanded will increase; as price rises, the corresponding quantity demanded will decrease.)

Discuss the assumptions made about demand and the Law of Demand. (We assume that all factors remain unchanged, except during the time period.)

What are some of these factors which could change that demand schedule? (Changes in income, tastes, price of related goods, substitutes or complements.)

Discuss how changes in these factors would affect demand schedule. (Increased income would increase quantity demanded at each price; small cars replacing large would decrease gasoline quantity demanded at every price; falling price of gasoline substitutes would mean more substitutes and less gasoline demanded at each price.)

Exercise IV: COMMUNITY ENERGY SURVEY

Students would survey their home and one other home for this project.

1) Have students design questions for the survey: design one survey based on questions received from entire class.
2) Surveys should ask questions which will help students determine the following:
   a) How much was spent on heating for months of October - March?
   b) What percentage of the homes surveyed have a backup heating source? If they do, what is it?
   c) How many homes use each type of energy as a heating source: wood, coal, gas, electric ity, solar, and fuel oil? (Percentage of use of each as a heating source should be identified.)
   d) Why do the people use their present heating fuel?
   e) If they used different types of energy, what would it be?
   f) Why would people convert to another fuel?
   g) Which fuel surveyed is the most desired?
   h) What prevents people from converting from one heating fuel to another?
   i) What would you do if your energy costs for heating doubled?
3) Students can use graphs in the presentation of the data.
4) Students can report the data to the class and/or community groups in an oral and written format.
5) Analysis of the data will show the pattern of fuel use in the community, and which users have the least dependence on a single energy source.
6) Students will explore how income influences the choice of fuels and/or backup heating systems. Discuss the alternatives given in the survey for doubling prices.
7) Students will determine approximate dollars spent by those surveyed for one source of fuel versus another source of fuel. Records could then be made of dollars spent on each fuel by the community.
8) Students will investigate the dollars saved by the community if the fuel consumption could be reduced by contacting the utility company for information and implementing suggestions.

Worksheet for Exercise IV: OPINION SURVEY[2]

1) Students will conduct an Opinion Survey: "Proposal for Reducing Energy Heating Use."
2) Directions: Rate the proposal using the following rating scale:
   1 = Strongly agree 4 = Disagree
   2 = Agree 5 = Strongly disagree
   3 = Undecided
3) Survey Questions:

a. Require an inspection of all homes checking for efficient home heating. 1 2 3 4 5

b. Lower air pollution standards so industries can burn high sulfur coal rather than oil or natural gas which causes less pollution. 1 2 3 4 5

c. Ban construction of homes not meeting energy conservation guidelines. 1 2 3 4 5

d. Ration the amount of heating energy to people's homes. 1 2 3 4 5

e. Reduce home heating temperatures by 5 degrees. 1 2 3 4 5

f. Require a time mechanism on all furnaces so that during the late evening less energy is used. 1 2 3 4 5

g. Reduce oil, natural gas, and electricity supples to all industries by 10%. 1 2 3 4 5

2 Adapted from Economics of Energy: A Teaching Unit (Gr. 7-12), Joint Council on Economic Education.

ACTIVITY #3 SCHOOL ENERGY SURVEY

GRADE LEVEL

Upper Elementary, Middle Grades, High School

TIME REQUIRED

7 - 10 Class Periods (50 Minutes)

RATIONALE

Schools are faced with problems of rising costs of energy and inefficient use of energy. Less than 20 percent of a school budget should be used for operation and maintenance costs. Utility costs comprise a small percentage of that 20 percent. However, as energy use and costs rise, utility costs take an increasing portion of that 20 percent thus leaving less for books, supplies, etc. The entire school building can be used as your energy classroom for energy conservation education. This can be an exciting teaching tool. This activity describes how students can participate in a school energy survey. They will observe areas in which energy is being wasted and identify ways in which energy can be used more efficiently. If students become interested and involved in the energy audit, they may develop a concern for more efficient use of existing energy supplies in their homes and communities.

OBJECTIVES

1) The student will identify simple maintenance and operating procedures to conserve energy.
2) The student will participate in a school energy survey.
3) The student will be able to identify the school's major energy wasters.
4) The student will study trade-offs and opportunity costs involved in energy conservation decision-making.
5) After the audit, students will discuss the feasibility of purchasing new energy-saving equipment and making modifications to the school building.

CONCEPTS

Conservation, energy management, decision-making, trade-offs, opportunity costs, scarcity, energy resources and investment.

STRATEGIES

Lecture, films, speakers, research and application.

BACKGROUND LESSON AND EXERCISE

Refer to Exercise:I on Opportunity Cost in Activity #2.

Excercise I: SCHOOL ENERGY SURVEY[1]

In the rush of playing "catch up" during the baby boom of the 1950's and 1960's the design and construction of our schools emphasized space over energy efficiency. Energy was cheap in those decades and having enough classroom space was essential. The walls of glass, the banks of lights, the over-sized equipment, and the rapid construction during the period are now millstones around the necks of school districts.

The past cannot be changed, but the present and future can. All occupants in the school building can take responsibility for more energy efficiency. Administrators, teachers, staff personnel, and students can pivot the axis toward accountable, judicious energy usage.

Conducting a Student Energy Survey of a school building may appear to be an overwhelming task to many educators. At first glance it would seem to require a technical expertise foreign to most teachers. Not true. Although some sophisticated energy equipment found in your school might require more time to understand than others, the greater part of the Student Energy Survey requires only common sense and application of readily available knowledge.

STUDENT OBJECTIVES

The Magic of Energy Surveys

Students can develop an energy awareness and some expertise in the field of energy conservation. Students with professional guidance, can perform an energy survey and follow-up analysis. This expertise can be shared with all the school to create a unified commitment to energy efficiency.

An energy survey is a physical tour of a building to determine how the building utilizes energy. The survey, if done well, identifies energy saving opportunities and suggests methods to accomplish each one. This information is recorded and the results analyzed for possible corrective action. The word "survey" is used deliberately here to distinguish the student activity from an energy audit, a more technical analysis of a building's energy usage.

Involving the students in a school energy conservation program can produce positive results. One school district in Wyoming assigned students and staff to energy teams in every building. Together they reduced the electrical bill by 50 percent in one year. In a Colorado district, the eighth grade curriculum requires every science student to participate in a school energy audit. Student participation, awareness and cooperation can help reduce energy usage. The results have an observable positive effect on the school climate.

Developing an energy ethic as a class can provide a school with an opportunity for caring, sharing and learning.

IMPLEMENTATION

In The Beginning

Student research in energy conservation, as in any other subject, is a good place to start. Although the grade level is a consideration, the methods and materials presented here can be modified for use from grades 6 through 12.

1. Begin by inviting an architect, mechanical engineer, or representative of your local utility company to speak to the class. Senior citizens knowledgeable in energy management also make excellent consultants. A letter to the U.S. Department of Energy or a trip to the State Energy Office will generate numerous pieces of literature on energy conservation, useful not only in the school but also at home.
2. Hand out survey, **Worksheet for Exercise I STUDENT SCHOOLHOUSE ENERGY SURVEY.**
3. Before conducting the survey, review with students the set of questions and activities in the Student Energy Survey. Ask each student to respond to the questions during and after the energy tour. It is suggested that the students carry the survey forms on the tour for quick reference and review. The teacher is encouraged to have the building tour conducted by a knowledgeable energy "expert" (from the local school district, utility, or community) who is familiar with the building. Encourage the custodian to join the tour so that he/she feels part of the "team." The teacher, custodian or "expert" should plan the route for the survey, and carry a set of master keys to open doors to the many areas they will visit. Also, light meters and mercury thermometers are essential. Allow time on the tour for questions.

1 This exercise was adapted from the SCHOOLHOUSE ENERGY EFFICIENCY DEMONSTRATION (SEED), Schoolhouse Energy Teaching Program developed by TENNECO, Inc. of Houston, TX.

TOUR THE BUILDING

4. A reasonable place to start an energy audit is the outside of the building. Many students pass through the entrance of their schools without really noticing the building structure. This survey is an ideal opportunity to sharpen their awareness of a part of the world where they spend a significant portion of their lives. As the students proceed inside the building, a new world of energy awareness should emerge. The most noticeable observations will be the temperature change and the lights. Students will become alert to conditions affecting instruction they may have never noticed. After spending a few minutes in the cafeteria, kitchen, the boiler/furnace room, and other areas of the school not usually accessible to them, students grasp the complexity of the educational system and expand their energy usage awareness and knowledge. After the energy survey has been completed, the class should have many unanswered questions. The teacher can request an energy "expert" to answer these questions, or suggest that the students do team research to find answers. Discussion and related projects also will stimulate a commitment to obtain responsible energy usage.

AFTER THE TOUR

After the students have returned to the classroom and the survey form is completed, it is time to review or "de-brief." The "expert" can respond to questions, analyze results, and discuss possible energy conservation options. Then the class can prepare a report for the principal or energy team. This report can be presented in written form or orally.

1. Discuss the tour. The teacher should review the section "Tips for the Teacher" and use as a basis for lecture and discussion.

2. Have students finish survey. As a conclusion to their survey, have students complete the following:
   a. List good energy management practices that have already been implemented in the school.
   b. List places you observed energy being wasted. Also state a possible solution for each item observed.

3. Lecture and discuss HANDOUT 3 B - "THE ENERGY AUDIT PROCESS."

4. Teachers may want to continue this activity with HANDOUT 3 C - "GOING BEYOND THE SURVEY." 5. SUPPLEMENTARY ACTIVITIES FOR OUTSIDE THE CLASSROOM:
   a. From HANDOUT 3 B, have students choose two solutions from the column labeled "SOLUTIONS" and write a paragraph on the opportunity cost of choosing one over the other.
   b. Invite a speaker from your local utility or business to speak on energy savings and energy costs.
   c. Have students choose an appliance, i.e. an electric range, and call different businesses to determine price of the range, and then compare the prices.

TIPS FOR THE TEACHER

Things to observe while on the tour (keyed to student survey form):

I. A Look At The School From Outside.

Most of us have had sufficient experiences with the exteriors of buildings to answer the questions in this section with little additional technical expertise. A telephone call or a quick visit to the individual that has the building's blueprints would answer the following key questions:

A. Do the roof and walls have insulation? How much?

B. Are the exterior lights controlled manually or by time clocks? The building engineer then can tell you their activation periods.

C. A quick survey of the condition of the building's exterior can be made while establishing the route the students will follow.

1. When starting the energy survey outside the building note the configuration of the building. Is it shaped like an E, H, T, rectangle, square, etc.?
2. What direction does the front of the building face? What direction do major entrances face? Which way does the prevailing wind blow? Does the building have any protection against prevailing winds, such as trees, or does it need any?
3. Note approximate percentage of wall area occupied by windows. What direction do windows face? Are they tight- fitting? Can they be opened? If they can, are they usually open during heating/cooling seasons?

4. Could the windows be double-paned or replaced by insulated walls? How would this affect internal illumination patterns? Note any cracked or broken windows. Plastic windows have the same heat loss as glass windows.
5. Do the exterior doors seal tightly? Are they out of alignment or do they close too slowly? Should double or vestibule doors be installed? What is the temperature difference between outside and inside, and how does this difference affect heat loss? When doors are open is there a "wind tunnel" effect in the halls?
6. Are the exterior walls in good condition and do their colors affect energy usage?
7. Are security lights efficient and effective? Do they actually reduce vandalism? What would happen if they were all turned out? Note what time they go on and off.

II. A Look Inside The School

Use the light meter while establishing the student route to observe and record existing lighting levels. The temperature readings may not be representative since the time of day and outside weather conditions usually affect them. These conditions may be different from those observed during the actual student survey.

Note: Ordinary fluorescent lamps are 3 times more efficient than incandescent bulbs. The high efficiency fluorescent lamps are 14 percent more efficient than the older models. It is important to know that ballasts should be disconnected in fixtures where fluorescent tubes have been removed. Ballasts are electrical transformers used in every type of lighting system except incandescent. They will continue to use electricity even if the tubes are removed. The custodian or other maintenance personnel will be able to help with this question.

Cleanliness is important. Dirt on any exterior glass or plastic fixture lens can reduce natural lighting an average of 20 percent. An extremely dirty window may become an unwanted shading device.

A. When the students are inside, have them record light levels using a light meter, and note temperature levels using a mercury or digital thermometer. Be sure body heat is not allowed to affect readings. Light readings are most realistic if made at table or desk-top level. Although it is not necessary to visit every area of the building, it is important to select representative classrooms, restrooms and corridors. Observe other areas from hallways.

B. Be sure students record where lights are unnecessary or too bright. Also look for energy waste where lights have been left burning in unoccupied areas. Discuss how the colors of the walls affect light levels. Students could calculate how much energy would be saved if energy-saving fluorescent tubes (35 watt) were installed throughout the school. If fluorescent lamps have been removed, have students check to see if the ballasts are disconnected. Ask why this is important.

C. Students will be interested in knowing if the light switches are conveniently located and used. Remind students to observe how the natural light is utilized. Are window shades used to optimize natural lighting?

D. Ask the students' opinion concerning sky lights. Are the lights, fixtures, and skylights clean? Discuss how much dirty windows, fixtures, and lamps affect natural lighting.

III. Cafeteria/Kitchen

Prior to the survey and at his/her convenience, meet with the individual in charge of the kitchen to discuss the special equipment and the number of hours it is used. Explain the purpose of the survey and request assistance when the students visit this area. If proper working attitudes are established, the students not only will be made aware of the kitchen's energy use pattern but will develop a greater respect for those individuals preparing and serving food in their school.

A. When visiting the kitchen have the students ask the supervisor about pre-heating practices, baking schedules, and the types of energy-using equipment necessary to produce the meals.

IV. Exhaust Fans

Exhaust fans can be energy wasters, not because they use much energy themselves (they actually use relatively little), but because they expel cooled or heated air to the outside. And they may do this 24 hours per day, 365 days per year!

Many exhaust fans have no dampers (air flow adjusters). Even when the fans are inactive, they allow tempered air to escape to the outside via the "chimney effect." Some exhaust fans have been found operating backwards.

A. Have students count exhaust fans as they tour the building. Check industrial arts area, kitchens, restrooms, and auditoriums. Make note of the size, operating times, and methods of fan control.

V. Hot Water For Washing

If electricity is used for heating water, the heater should only operate during late afternoons, evenings, or at night in order to avoid peak demand periods and excessive demand charges. If hot water is needed during peak demand periods, the school may consider installing smaller, separate water heaters. Electric bills include an energy charge and a demand charge. The former is based on consumption of fuel required to generate electrical energy; the demand charge is directly related to the power required by the building. Whether the building has an electrical demand meter can be determined by examining the meter or the electric bill for columns labeled "Measured Demand" and "Billing Demand."

A. Do water faucets drip or have excessive pressure? Students can consider whether water restrictors would reduce waste. What hot water temperature is required by the local health code? How is the water heated? Are water pipes insulated? Does the water heater need to be relocated?

VI. Heating/Cooling System and Heating Control Room:

Before planning this segment of the instructional tour, make an appointment with the individual in your district who supervised the maintenance of the heating/cooling equipment. The appointment should not last over 45 minutes, but should include a personal tour of the heating/cooling room(s). This individual can provide all of the information needed for this section of the energy survey. For example:

A. What type of heating or cooling system is used: hot water, steam, forced air, etc?
B. How does the basic system work and what energy source(s) are required?
C. What are the required maintenance procedures and are there problem areas?
D. What is the location of the time clock(s) and how and what do they control?
E. Why was this type of heating/cooling system chosen and when was it installed?
F. How does the heating/cooling get to the classroom or hallway? How does the return air get to the heat source?
G. Have students note if the vents or heating elements are clean and unblocked. Havethem judge whether the thermostats are properly located and controlling the temperature. Are the thermostats too easily "adjusted" by unauthorized persons?
H. Visiting the boiler/furnace room and listening to an explanation/demonstration of how these systems work can be very informative. Have the custodian demonstrate the clocks, the night set-back system, and other control features that make the heating/cooling unit(s) operate more efficiently. Request that students always be alert for cleanliness. Dirt is an insulator, but not a desirable one.

Worksheet for Exercise I
STUDENT SCHOOLHOUSE ENERGY SURVEY

Student's Name ______________ Grade Level ______________ Room Number ______________

School ______________ Number of Students ______________

Length of School Day ______________ Hours for Cleaning ______________

Monthly Heating/Cooling Costs ______________

A Look At The School From Outside

A. Draw an outline of the school in the space below.

B. What direction does the school entrance face? ______________

Which way does the wind usually blow? ______________

What protection does the building have? ______________

C. Does the school have many windows? ______________ Many ______ Some ______ Few ______

What percent of the wall area is windows? ______ %

How many windows face South? ______ North? ______ East? ______ West? ______

Can the windows be opened? ______________ Are the windows tight-fitting? ______________

Should any windows be double paned? ______ Where? ______________

D. Could energy be saved by replacing selected windows with insulated walls or insulating material? ______________

Are any windows cracked or broken? ______________ How many? ______________

E. Do the outside doors fit tightly? ______________ Do doors need weatherstripping? ______________

Should there be double doors at any of the entrances? ______________

F. Are the outside walls in good condition? ______________________________

____

Of what material are the outside walls made? ______________________________

____

Is there insulation in the walls? ______________________________

____

How does the color of the walls or roof affect energy usage? ______________________________

____

G. Is the security lighting effective in preventing vandalism? ______________________________

____

How many hours are these outside lights turned on? ______________________________

A Look Inside The School

H. Note the following for each area listed below:

Area	Color of Walls	Lighting Level in Footcandles	Type of lighting incandescent/fluorescent	Other	Temperature
Halls					
Offices					
Classrooms					
Gym					
Cafeteria					
Library					
Other					

How does the color of the walls affect lighting? ______________________________

____

I. List any areas of the school where there are unnecessary lights: ______________________________

List any rooms where the lights appear too bright: ______________________________

List any areas where lights appear too dim: ______________________________

Does the school use energy-efficient fluorescent lamps? ______

Mercury vapor? ______ Other? ______

If fluorescent lamps have been removed are the energy-using ballasts disconnected? ______

J. Are there areas where lights have been left on when no one was present? ______

List: ______

Are the light switches located for easy use? ______

Is the natural light from windows used properly? ______

K. How does keeping the following clean affect energy usage? ______

Windows ______

Light Fixtures ______

Skylights ______

Cafeteria/Kitchen

L. What energy sources are used in the kitchen? ______

Natural gas ______

Electric ______

Other ______

List kitchen items using energy (not human) and hours they are used:

Item	Hours Used

Is the kitchen well arranged to use energy efficiently? ______

Is heat-producing equipment located next to cooling equipment? ______

Exhaust Fans

M. Check the hours exhaust fans operate in the following areas:

Restrooms _____ Kitchen_____ Art_______ Industrial Art________ Other ______________________________

How are most exhaust fans controlled? ______________________________

Hot Water For Washing

N. What is the temperature of the hot water as it comes from the tap in:

Restrooms ______________ °F (____________________ °C) C = 5/9 (F- 32)

Cafeteria/Kitchen ____________ °F (____________________ °C) F = 9/5(C+32)

Dishwasher ______________ °F (____________________ °C)

Do any faucets drip? ________ Where? ______________________________

Measure the gallons per minute from a faucet ______________________________

How many BTU's are used per hour by the water heater? ______________________________

If electricity is used to heat water, does the heater only turn on at night? ______________________________

Heating/Cooling System

O. Do the thermostats control the room temperature accurately? ______________________________

Are the thermostats well placed? _______ What is the night thermostat setting? _______ °F (______ °C)

What are the day settings of thermostats? _________ °F (____________ °C)

P. Is there good air movement from the heating/cooling equipment? ______________________________

Is untreated outside air used for cooling when possible? _____ Are the heating/cooling elements kept clean? _______

Do the infrequently-used areas have lower thermostat settings for heating? ______________________________

Heating Control Room

Q. If the school is heated by a boiler or furnace, what are the BTU's used per hour? ______________________________

Do the heating unit(s) appear clean and well maintained? ______________________________

When was the last time the flame/air settings had an efficiency check? ______________________________

Is the time clock on the right day and time? ______________________________

What hours does the time clock allow the heating system to operate on day setting? ______________________________

Night setting? ______________________________

What fuel is used to heat the school? ______________________________

Handout: THE ENERGY AUDIT PROCESS

A valuable tool being used by energy managers is the energy audit. An energy audit is a complete survey of a building which identifies how energy is consumed and determines opportunities for energy efficiency.

The energy audit process is simple and consists of the following.

- Data gathering phase - Gathering of architectural, mechanical and electrical specifications, utility bills, and weather data.

- Preliminary analysis - Examination of all written data to find areas of energy waste.

- Building Examination - A complete, on-site inspection, usually conducted when the building is under full load conditions.

- Final analysis and report - Includes a detailed analysis of how a building uses energy, identifies opportunities for energy efficiencies and recommends appropriate action.

While some of the above-mentioned process may require analysis too complicated for the non-technical, non-engineering member of the school community, everyone can be involved. Much of the energy that can be saved is saved through the vigilance and cooperation of people. The observant person is invaluable in energy conservation activities.

In order to assist the non-technical person with becoming more aware of energy usage, SEED (Schoolhouse Energy Efficiency Demonstration) has developed a checklist of typical school energy problems and possible solutions. The list is divided into three major categories: The building envelope, or outside surface of the building; mechanical and electrical equipment; and, special systems.

Problems	Solutions
Building Envelope	
Air filters in/around windows and doors.	-Caulk and weatherstrip. -Replace window gaskets. -Install vestibules at most-used entrances and exits. -Replace broken windows or doors. -Plant wind break to deflect winds.
There are excessive glass and window areas.	-Insulate the upper portion of windows. -Reduce excess glassed areas, e.g., in corridors, entrances and upper portion of classroom windows.
There is insufficient roof insulation.	-Add insulation when other major roof repair is required.
Excessive outside air is admitted through unit ventilators.	-Adjust dampers. -Replace a restrictor, such as pegboard, over outside of the fresh air inlet to reduce the amount of air entering the unit ventilator.
Exhaust systems allow too much tempered air to escape.	-Place dampers on exhaust fans. -Install timers on exhaust fans -Disconnect unnecessary exhaust fans.
Mechanical and Electrical Equipment	
Rooms are too hot or too cold	-Calibrate thermostats. -Set thermostats at 68°F in winter. -Repair any broken fans, valves and pumps in heating system. -Keep doors and windows closed when system is operating. -Clean or replace filters regularly.

Problems	Solutions
Mechanical and Electrical Equipment (cont.)	
Rooms are too hot or too cold. (cont.)	-Check boilers to ensure they are operating properly.
Rooms have inefficient lights.	-Install high efficiency fluorescent lamps. -Install high pressure sodium lamps in gyms.
Existing lighting is not well used.	-Turn off unneeded lights on bright days. -Paint walls a light color to increase reflectivity.
Corridors and non-work areas are over illuminated.	-Disconnect unnecessary fixtures. - Disconnect ballasts where fixtures have been removed.
Heating system operates too frequently.	- Place system on timer so that it can be turned down or off when building is unoccupied.
Special Systems	
Miscellaneous energy over-use in kitchen.	- Avoid preheating the oven. - Operate dishwasher and oven only when full. - Clean refrigerator coils. - Replace refrigerator gaskets when necessary. - Do not leave exhaust fans running unnecessarily.

This list is not complete but does provide examples of what can be done. What is not addressed in this list is occupant or user education. People must be made aware that turning off lights and closing windows will make a significant difference.

Worksheet
GOING BEYOND THE SURVEY[2]

INSIDE THE CLASSROOM

In those classes with exceptionally alert students a successful activity has involved the design of an energy-efficient school house. A reinforcement of the learning activity follows when an architect or engineer analyzes the plans with the class.

Other activities that can extend the use of the school as an energy conservation laboratory are:

1) Suggest students research the addition of a solar heating system to the school to discover if it is practical and efficient.
2) Have students develop checklists to grade members of the student body and staff on energy management habits.
3) Have the students design reminders to aid occupants in turning off lights.
4) Have student teams read the electric or natural gas meters twice a day to record usage. A two-week experiment will indicate how much is used days, nights, and weekends.
5) Assign a group of students to research and report on what their classroom, clothes, and school activities would be like if they lived in the early 1900's. Another group could do "Life in the year 2010." Relate how energy usage affects standards of living.
6) Have students secure copies of utility bills for the school and graph usage patterns over the past two years on a monthly basis. Students could graph costs for this period and display findings in a busy hallway or other areas where they will be easily observed. Additional activities will emerge as you proceed through the energy unit, both through your imagination and student enthusiasm.

OUTSIDE THE CLASSROOM

The following five projects provide examples of opportunities to extend the Student Energy Survey beyond the scope of the schoolhouse.

1. "HOW OUR SCHOOL USED ENERGY" - A SLIDE PRESENTATION

After the Student Energy Survey has been completed,

2. This activity was adapted from the SCHOOLHOUSE ENERGY EFFICIENCY DEMONSTRATION (SEED), Schoolhouse Energy Teaching Program developed by TENNECO, Inc. of Houston, TX.

students can adapt the information into script form. Student photographers can take slide photographs of the building's energy systems, depicting examples of energy use and misuse which will coordinate with the script.

The student production can then be presented to other classes, faculty, the Board of Education, and/or community groups. A show of this type can be especially helpful if examples of good home energy management are included.

2. STUDENT ENERGY WEEK

Students and staff can plan and develop an exciting school-wide "Energy Week." For example, the following components can be included:

a. Speakers from energy-related industries to discuss emerging energy technologies, e.g., shale oil, coal gasification, tertiary recovery, etc;
b. Alternative Transportation Day, e.g., walking, car pooling, roller skating, etc.;
c. Reduction of heating and lighting levels to dramatize potential life system changes;
d. Fashion shows which illustrate our dependence on petroleum-derived synthetics and the available options;
e. Energy-conscious meals provided by the cafeteria;
f. Disconnection of the vending machines; and,
g. Non-use of petroleum- derived instructional materials, e.g., transparencies, ditto fluid, etc.

3. LOCAL GOVERNMENT BUILDING SURVEYS

Utilizing the Student Energy Survey forms, students can tour local government buildings to determine energy usage patterns. Results of these surveys can be presented to the mayor, city council and/or citizen groups.

4. COMMERCIAL ENERGY FAIR

Local merchants can be invited to display alternative energy/conservation devices in a designated area of the school. Parents and interested citizens should be encouraged to share ideas and observe the exhibits. Various weatherization techniques can be demonstrated by students or professionals. Also, student projects can be displayed.

5. RADIO PROGRAMS

Students can be encouraged to produce a weekly energy conservation radio spot which can be pre-taped and aired on the local station. This type of program might include energy conservation tips, renewable energy technologies and interviews with energy experts and politicians.

ACTIVITY #4 ENERGY MANAGEMENT IN THE SCHOOL

GRADE LEVEL

Elementary

TIME REQUIRED

2 - 4 Class Periods (50 Minutes), On-going Project

RATIONALE

It takes many dollars to pay for rising energy costs in our schools. The opportunity cost is that these funds are diverted from other important areas within a school. Through implementation of simple energy conservation techniques in our schools, dollars can be saved, and students' awareness of energy consumption and conservation can be increased. Students can identify energy—wasting areas in the school and explore ways the savings generated by conservation could improve their school. Students can encourage others to cooperate in this energy management activity.

OBJECTIVES

1) Students will identify areas in which energy is being wasted or used inefficiently within their school.
2) Students will discuss current energy management that has waste or inefficiency.
3) Students will study the relationship between energy conservation and reduced utility costs and use.
4) Students will study various energy-saving techniques that would benefit their school.
5) Students will discuss the conflicts between two economic goals: freedom and efficiency.

CONCEPTS

Inefficient use of energy, energy conservation, energy awareness, opportunity costs, savings, trade-offs, economic goals of freedom versus efficiency and specialization.

STRATEGIES

Lecture, films, speakers, hands-on activity and demonstration.

BACKGROUND LESSONS AND EXERCISES

In order for students to develop ways for energy-saving techniques and increase energy efficiency in their schools, they need to consider the goals they wish to achieve, socially and economically. As is often the case, while the social and economic goals may be similar, achieving the goals themselves may result in directly opposite results. Such is often the case with the two social and economic goals discussed in this activity: freedom and efficiency.

Exercise I: ECONOMIC GOALS

ECONOMIC FREEDOM

As an economic goal, freedom refers to consumers and producers having the right of making decisions to allocate their resources as they wish. As a consumer, it may be what dress, shirt, or record album to buy. A producer's freedom is what good or service to produce, what job or career to enter, or whether to join a union. While complete economic freedom sounds ideal, some individuals or groups suggest certain freedoms must be limited to better achieve the other economic goals of efficiency, equity, stability, security, or growth. How can limiting economic freedom better economic efficiency?

ECONOMIC EFFICIENCY

Efficiency can have two entirely different meanings. Technically, it can refer to producing the most output using the least amount of input. Technical efficiency can be achieved by increasing outputs with given input levels, or maintaining an output level while decreasing inputs. In a broader sense, economic efficiency refers to obtaining benefits through our market decisions that exceed additional costs. Conflict with economic freedom arises if consumer or producer freedoms in decision-making result in the additional benefits of those decisions exceeding the costs involved.

The following exercise will provide students an opportunity to compare economic freedom and economic efficiency. It may also serve as a follow-up to the School Energy Management Activity.

Worksheet for Exercise I: A WRITTEN REPORT

1) Students will prepare a written report answering one of the following:

   a) List some ways to better manage our energy resources, and explain how they affect efficiency.

   b) How much money will be saved, and how can it be used to better our school?

   c) The most efficient use of resources minimizes the cost to both producer and consumer. Explain.

   d) Explain and give examples of the conflict between freedom and efficiency in this activity. You may wish to use a decision-making grid on any of the above, perhaps for bonus points.

Example of a decision-making grid using topic (d):

	Criteria					
Alternatives						Total Score

Exercise II: SCHOOL ENERGY MANAGEMENT [1]

IMPLEMENTATION

1) Assign students to school energy management watch teams.
2) Prepare badges for students to wear during their patrol.
3) Assign clipboards or notebooks to each team member to record problems encountered during the patrol.
4) Survey and list energy uses in school building, i.e. computers, air conditioning, kitchen.
5) Brainstorm ways in which to reduce energy consumption, i.e. lower lighting level in some rooms, turn off lights in rooms not in use, close classroom blinds at night. 6) Apprise students of various items to look for during patrol that are energy wasters. (Have speaker in from an energy company?)
7) Formulate a record-keeping form for the energy watch rounds. This could be a group activity with entire class voting on the final form to use.
8) Students could do their energy watch rounds during recess, lunch, and after school; record their findings; correct problems, i.e. shutting off lights in rooms not in use.
9) Design and implement a school/community-wide awareness campaign to elicit students' cooperation. Students will design posters, announce their campaign over the PA, and/or write articles for the school newspaper.
10) Invite the school business manager or appropriate person to speak to your class and answer questions on energy and costs. Students will examine the school's utility bills for the last year.

1 This exercise is an adaptation of the "Energy Patrol," DeVargas Elementary Schools in San Jose, California. Their Energy Patrol is composed of 20 fourth, fifth, and sixth graders who turn out lights at recess, lunch, and after school. Energy costs at DeVargas Elementary Schools were reduced by approximated $1,000 the first month of the Energy Patrol's activity.

11) Calculate the past, current, and progressive use of energy through a comparison of the monthly utility bills for the school. Note weather changes, daily records of temperature, records of sunny and cloudy days. All records can be kept for use in comparison with previous bills.
12) Other related activities: bulletin boards on conservation, designing signs to place by all light switches, visit to local utilities, an air-flow study, awards to classes that have consistently turned off their lights.
13) Students can use the format in the example to record energy consumption, or devise a form that would be appropriate to their needs. (See Worksheet for Exercise II: ENERGY IDEAS) Issues to be focused on should be:
   - reduced energy consumption,
   - lower utility costs,
   - increased awareness of energy conservation, and
   - economic impacts within the school.

This could be an interdisciplinary activity as follows, using all students on a rotating basis:

- Math Students - can do the calculations and reading of KW hours.
- Language and Art Students - can do the posters and PA announcements.
- Science Students - can do the temperature readings.
- Social Studies Students - can do the actual energy watch.
- Publications Class - can do reports for school paper.

Worksheet for Exercise II
ENERGY IDEAS

CUPERTINO UNION SCHOOL DISTRICT
Energy Consumption Record for DeVargas

BILLING PERIOD	ELECTRIC CONSUMPTION	DEMAND	GAS CONSUMPTION
February ____ 1981	18800 Kwh	____ Kw	2856 ____ Therms
February ____ 1982	13120 Kwh	____ Kw	1847 ____ Therms
% CHANGE	**Kwh**	**DEMAND**	**THERMS**
DOWN	30 %	____ %	35 %
UP	____ %	____ %	____ %
CURRENT ENERGY CHARGES	$0.08/Kwh		$0.50 /THERM

	ELECTRIC CONSUMPTION		GAS CONSUMPTION
DISTRICT TOTALS:	**Kwh**	**DEMAND**	**THERMS**
THIS MONTH	DOWN 15%	____ %	17%
	UP ____ %	____ %	____ %
TOTALS TO DATE	DOWN 11%	____ %	23 %
	UP ____ %	____ %	____ %
COSTS AVOIDED TO DATE		$38,207.00	$50,600.00
Total to Date			$88,807.00

ACTIVITY #5 WINDOW TREATMENTS FOR ENERGY EFFICIENCY

GRADE LEVEL

Middle Grades, High School

TIME REQUIRED

2 - 4 Class Periods (50 Minutes)

RATIONALE

Windows are a major source of significant energy loss. The Department of Housing and Urban Development conducted a study which concluded that a home with no outside doors or windows would require 70 percent less heating fuel and 46 percent less air conditioning power. As much as 20-50 percent of an average home's heat leaves through the windows. How to make economic decisions about the most energy efficient window treatment is important in using our energy more wisely and in getting the most for our energy dollars. As with other economic decisions, choices about energy alternatives must be made because energy resources are scarce. This lesson provides a rational approach to making these decisions that will make your school and/or home more energy efficient and save energy dollars.

OBJECTIVES

1) Students will list the steps involved in decision making.
2) Students will construct a decision matrix.
3) Students will describe how windows lose heat.
4) Students will calculate heat loss.
5) Students will use a decision matrix to decide among window treatment alternatives.
6) Students will list the advantages and disadvantages of window treatments and define the opportunity costs of choosing one alternative.

CONCEPTS

Economic decision making, energy conservation, R-value, scarcity, limited resources and opportunity cost.

STRATEGIES

Lecture, research, reading, guest speakers, application and oral presentations.

BACKGROUND LESSON AND EXERCISE

Scarcity and Decision Making

Making energy efficient window treatments are in demand by consumers. There are many types from which to choose, and some are more energy efficient than others. You want to choose a window treatment that meets your needs, tastes, and solves the energy problem. Each type will vary in cost, attractiveness and efficiency. The choice is up to you, and the energy decision-making grid will help you make a rational choice as to the best alternative in energy efficient window treatments. Problem-solving and making choices lie at the heart of economics because of the condition of scarcity. Scarcity means that productive resources are limited relative to peoples' wants. Because this is true of energy resources, this forces people to make choices about how to use these limited energy resources more effectively to satisfy wants. Making a choice can be difficult, and it usually helps to use a reasoned approach to make an energy decision.

A Reasoned Approach to Decision Making

A reasoned approach to energy and economic decision-making involves the following steps:

1) State the problem or issue. Identify the important facts.
2) Determine the feasible alternatives.
3) Identify the criteria or goals to consider for the alternatives.
4) Evaluate each alternative according to the criteria.
5) Make a decision based on the overall evaluation. This five-step process may not lead to a simple solution of a problem. In fact there may be several possible or acceptable alternatives. What the process is designed to do is to get you to consider the important dimensions of a problem before you make a decision.

Exercise I: DECISION-MAKING

Ann and John have a 17-year old home. They are considering remodeling some rooms. One of their projects involves the windows in the home. They have calculated the heat loss of each window and have determined the heat loss from each window is substantial. Instead of replacing each window, which is more costly than they can afford at this time, they have decided to invest in energy-efficient window treatments. They do have a limited budget for remodeling. They have to make some choices concerning the best window treatment for their windows. What will they decide?

1. Identify the problem. "Choosing the most energy-efficient window treatments within Ann and John's budget."
2. Possible alternatives listed. These are not the only ones.
3. Criteria for evaluating listed alternatives.
4. Evaluate each alternative in terms of the important criteria, using "+" and "-" system.
5. Make your decision. In this case the decision involves choosing one energy efficient window treatment that may not be as attractive as one that is more expensive (trade-offs).

	CRITERIA						
ALTERNATIVES	SEAL				Payback		TOTAL
	Top	Bottom	Sides	Center	Period	Cost	SCORE

Exercise II: ENERGY DECISIONS AND COSTS DEFINITIONS

Opportunity Costs - refers to foregone best alternative use of the resource.
Scarcity - limited resources versus unlimited wants.
Real Cost - refers to what is given up (see opportunity costs).
Cost-Benefit Analysis - comparison between what you are giving up (costs) and what you believe you will receive (benefits) from your decision.

DIRECTIONS:

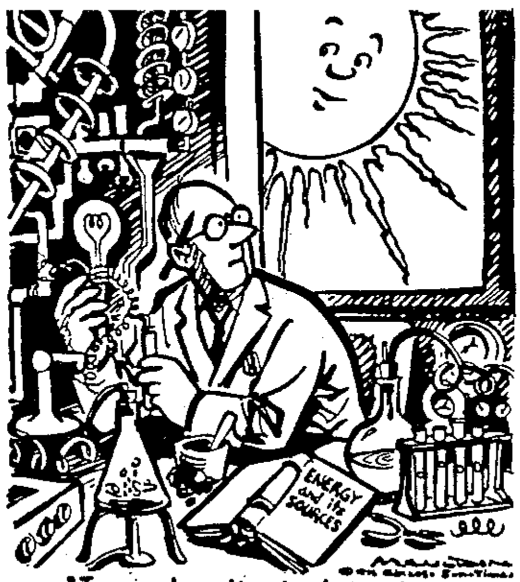
1. Divide students into small groups of ______. Give each group an imaginary amount of money to spend on window treatments and energy.
2. Have students choose window treatments. List advantages and disadvantages of each, remembering that dollar cost is a factor as well as energy dollars saved.
3. Use a decision-making grid to choose best alternative. A sample decision-making grid follows.

Criteria Alternatives	Cost within budget?	Energy Savings Exceed Cost	Attractive Design	Easy to Install	Easy to Remove	Total
Shades #1						
Film #2						
Shutters #3						

Exercise III: CARTOON

DIRECTIONS:

1. Students will discuss the cartoon using the given question about symbolism and interpretation.



"Try me, doc—I'm already turned on."

Symbolism:
Who is the man in the picture?
What does the face in the window represent?

Interpretation:
What is the man in the picture trying to do?
What is the artist trying to say in the cartoon?
Which energy sources are becoming scarce in the world?

Exercise IV: WINDOW HEAT LOSS

DIRECTIONS:

1. Students will read HANDOUT I, "Window Heat Loss." Discussion or quizzing of students may follow.
2. Students will read HANDOUT II, "Calculating Heat Loss." Review the formula in class so all understand how to do it.
3. Assign rooms to groups of students. Each group will calculate the heat loss of windows in the assigned rooms.
4. Each group will present their findings orally to the class and administration.
5. Discuss the decision-making grid in the Decision-Making Exercise. Work through sample problems in class.
6. Assign each group the task of using the decision-grid to assist them in making a choice as to which type of window treatment to recommend for their assigned room.
   a. Students will have to research for different kinds of treatment, fabric, efficiency, cost, etc. to evaluate criteria for a decision-making grid.
   b. Guest speaker from local business or county extension could be helpful.
   c. Materials available through a paint store, fabric tore, county extension office would be helpful in this activity.
7. Oral presentations of each group's recommendation should be given to class.
   a. Graphs would be useful in presentation.
   b. Decision grid display should be part of presentation.

Handout I: WINDOW HEAT LOSS

In order to evaluate the energy efficiency of windows, the basic processes of heat transfer should be understood. They are: radiation, convection, and conduction. **Radiation** occurs when heat waves from sunlight pass through the glass, warming objects on the inside. As sunshine passes through windows, this radiant energy is absorbed by the walls and furniture. In turn, these warm, interior objects also release heat back into the room. **Conduction** occurs when heat is transferred through a material from a warm surface to a cold space. Glass is an excellent conductor of heat. Heat from inside the house strikes a cooler glass surface and passes heat through glass to the outside.

Convection occurs when there is a temperature difference in the room air. Cold air is heavier and tends to sink while the lighter warm air rises. Air which is between the draperies and glass is cooled by contact with the glass. As this cool air falls, it causes warm air to be drawn into the space through the gap between the drapery and the wall. This air is cooled, continuing the cycle. Sealing the gap between the drapery and the wall can prevent this effect.

In order to reduce these energy losses and movement of air through and around a window, the window's R-Value must be increased. The higher the R-value of a window, the greater insulation value.

Handout II: CALCULATING HEAT LOSS

Use the following formula to figure heat loss through any given "construction."

A construction is a combination of layers of different materials. A window construction might consist of a storm window, an air-space, a window, and a drapery.

It is the same formula used to calculate heat loss for a wall, ceiling, or floor.

If you follow the step-by-step directions you will find it easy to use. You can do all the math by hand. A calculator will speed up the process.

$$H = 24 \times HDD \times U\text{-value} \times ft^2$$

H is the window's heat loss in BTU's (A BTU or British Thermal Unit is a standard measure of heat).

24 represents a 24-hour day.

HDD represents Heating Degree Days (see Table 1 for the HDD Value for your weather station).

U-value is the amount of heat energy, in BTU's, transmitted by 1 square foot of a construction in an hour, when the temperature difference inside to outside is 1^0F.
In other words, the U-value represents the ability of the construction to let heat pass through. The smaller the U-value the lower the heat loss.

To get the U-value add all R-values for typical window materials found in Table 2. After you have added the R-values, divide them into 1. This gives the U-value. The mathematical formula for U-value looks like this:

$$\text{U-value} = \frac{1}{(R1 + R2 + R3...)}$$

FT^2 represents the window's square feet of surface area. To obtain square feet, multiply window height times width. Hint: if you measure the window in inches, multiply height x width to obtain the total square inches. Then divide by 144 to obtain the square feet. Let's see how the formula works.

CALCULATING HEAT LOSS

A family in Broken Bow, Nebraska, wants to know how much energy they are losing from their living room picture window. The window is double pane glass with 1/4-inch air space between the glass. The window is presently covered with loose draperies. The window measures 48 x 60 inches.

HDD = 6740

U-value =

$$\frac{1}{R1 + R2} = \frac{1}{1.50 + .20} = \frac{1}{1.70} = .5882$$

(1.50 = double pane; .20 = conventional drapery)

U-Value = .5882
$ft^2 = 20$

Putting these values into the heat loss formula:
$H = 24 \times HDD \times U\ value \times ft^2$
$H = 24 \times 6740 \times .5882 \times 20$
H = 1,902,945

The family is losing 1,902,945 BTU's of energy out their living room window each year.

CALCULATE COST OF HEAT LOSS

Once you have determined the heat loss in BTU's, you can figure the dollar cost.

First divide the heat loss in BTU's by 1,000,000. Then, look up the cost for the type of fuel you use in Table 3 or use your own local costs if available. Take the dollar value in the right-hand column and multiply it by the number of million BTU's used. This will give you the dollar cost of heating the window for one year. This is the mathematical equation:

$$\$ = \frac{\_\_\_\_\_\_}{1{,}000{,}000} \times \text{Cost for 1 million BTU's usable heat}$$

EXAMPLE

The family in Broken Bow is losing 1,902,945 BTU's each year out the living room window. They want to know how much it costs them in dollars for this lost heat. They have been heating their home with propane gas for about five years.

$$\$ = \frac{1{,}902{,}945}{1{,}000{,}000} \times 9.73$$

$$\$ = 18.52$$

It costs about $18.52 each year for heat lost through the living room window.

Table 1.

Annual heating degree days for Nebraska stations. (1 HDD = 1^{0}F difference between inside and outside temperatures for a 24-hour period).

Station	Annual	Station	Annual	Station	Annual
Ainsworth	6726	Falls City	5475	Mullen	6546
Albion	6796	Fort Robinson	7025	Norfolk	6981
Alliance	6946	Franklin	5732	North Loup	6545
Alma	5753	Fremont	6117	North Platte	6743
Arthur	6902	Geneva	6084	Oakdale	6920
Ashland	6197	Genoa	6320	Ogallala	6446
Atkinson	6825	Gordon	7306	Omaha Eppley	6049
Auburn	5636	Gothenburg	6139	Omaha North	6601
Beatrice	5819	Grand Island	6420	O'Neill	6960
Beaver City	5647	Halsey	6684	Osceola	6317
Benkelman	5766	Harrison	7766	Oshkosh	6501
Big Springs	6368	Hartington	6827	Osmond	6903
Blair	6437	Hastings	6070	Pawnee City	5426
Box Butte	7269	Hayes Center	6284	Purdum	6657
Bridgeport	6434	Hay Springs	7189	Ravenna	6261
Broken Bow	6740	Hebron	6010	Red Cloud	5859
Burwell	7042	Holdrege	5926	Saint Paul	6359
Butte	6886	Imperial	6122	Scottsbluff	6774
Cambridge	5893	Kearney	6467	Seward	6063
Central City	6197	Kimball	6723	Sidney	6564
Chadron	7031	Kingsley	6169	Stanton	6677
Clarkson	6582	Lexington	6309	Stapleton	6650
Clay Center	5998	Lincoln	6218	Syracuse	5961
Columbus	6297	Lodgepole	6233	Tecumseh	5890
Crescent	6811	Loup City	6541	Tekamah	6330
Crete	5922	Madison	6586	Valentine	7300
Culbertson	6102	Madrid	6179	Wakefield	6860
Curtis	6115	McCook	5714	Walthill	6843
David City	6261	Merriman	6955	Weeping Water	6056
Ewing	6919	Minden	6002	West Point	6602
Fairbury	5986	Mitchell	6907	York	6082
Fairmont	6086				

Source: Path to Passive, Nebraska Energy Office, 1982

THE DIFFERENCE WITH AN ENERGY-EFFICIENT WINDOW TREATMENT

To determine how much difference a more energy-efficient window treatment would make, you simply refigure the heat loss and fuel cost again, using the R-values for the particular window treatment you are considering. Add to the window treatment R-Value, the basic R-values for your window glass, storm window, and any air spaces.

Then determine how much you can save by subtracting the cost of your desired window treatment from cost of your present window heat loss.

EXAMPLE:

The same Broken Bow family wants to improve the window's energy efficiency. They want to use an insulated Roman shade, but first they want to know if that will save money. They want a shade with a medium of bulk, so they are planning to use two layers of fiber-fill for insulation.

$$H = 24 \times HDD \times U\ value \times ft^2$$

(Note: The only value that changes this time is the U-value for the window and window treatment.)

U value =

$$\frac{1}{\underset{\text{double pane}}{1.50} + \underset{\text{air space}}{.9} + \underset{\text{fiber-fill batting}}{3.12}} = \frac{1}{5.52} = .1811$$

Putting this U-value into the heat lost equation:

$$H = 24 \times 6740 \times .1811 \times 20$$
$$H = 585{,}895$$

The window would only lose 585,895 BTU's each year with Roman shade. Cost of the heat loss with the shade is figured in the same way as figuring the loss with the drapery:

$$\$ = \frac{585{,}895}{1{,}000{,}000} \times 9.73$$
$$\$ = 5.70$$

Subtracting this cost from the original heating cost will show how much money each year would be saved with the addition of the insulated roman shade.

$18.52 original heating cost
-5.70 heating cost with Roman shade
$12.82 saved each year by adding the insulated roman shade.

CALCULATE PAYBACK PERIOD

Saving money with insulating window treatments is important. It is also important that the cost to install the window treatment is paid back within a reasonable time.

The length of the payback period also depends on how much the window treatment costs in the first place. If two windows of exactly the same size are located in a home, the homeowner might choose two different window treatments, especially if the windows were in different rooms. One treatment might cost twice as much as the other. If both saved the same amount of heat each year, it would still take twice as long to pay back the costs of installing the more expensive window treatment.

Table 2 Approximate R-values for selected materials.

Material	R-value*
Single pane glass[1]	.90
Double pane glass[1]	
1/4-inch air space	1.50
1/2-inch air space	2.00
Triple pane glass[1]	
1/4-inch air space	2.55
1/2-inch air space	3.22
Storm windows	
1 pane plus air space	2.00
Air space	
3/4-inch to 4 inches deep	.90
Drapery	
Conventional (not insulated; not sealed)	.20
Two-layer system (drapery & lining on separate tracks)	1.94
Roller-shade[2]	
Conventional	.18
Side tracks	.96
Venetian blinds[2]	.20
Interior shutter[2]	
3/4-inch polystyrene core between 1/8 inch plywood panels	4.90
Fiberfill batting[3] (5/8-inch thick per layer)	
1 layer	1.56
2 layers	3.12
3 layers	4.68
Fiberglass batts[4]	
1-inch thick	3.20
Rigid foam insulation board[4] (1- inch thick)	
polyurethane	6.10
polystyrene (beadboard)	3.40
polystyrene (styrofoam)	3.80

1 ASHRAE Handbook of Fundamentals, 1977. 2 U.S. Dept of Energy A comparison of Products for Reducing Heat Loss Through Windows, 1981. 3 Wisconsin Energy Extension Service. What About Windows? 1978 4 Agnet HOUSE program *Values are from a variety of sources and must be used with caution. Existing window conditions (installation factors, all leakage characteristics, product variations) will alter calculations of installed product performance. 5 Costs established by the Department of energy, March 19, 1984. To use your own fuel costs use this equation for determining $ cost/million BTU's: (cost/unit) x (1,000,000)(BTU/unit) x(%efficiency). 6 Furnace efficiencies vary with age and maintenance practices. Newer units have higher efficiency than the older units. Well maintainedunits will also have higher efficiency. Rates in table are for comparison to newer units. 7 BTU stands for British Thermal Unit. 8 kwh stands for kilowatt hour.

Table 3.

Cost of fuel.[5]

	Cost/unit	Furnace efficiency[6]	BTU/unit[7]	$ Cost/million BTU's usable heat
Electric	7.63/kwh[8]	100%	3413	$22.36
Natural Gas	70/100 cu.ft.	75%	101,600/100 cu.ft.	9.19
	"	95%	"	7.25
Propane	84.2/gal	75%	91,000/gal	12.34
	"	95%	"	9.73
Oil,#2	1.09/gal.	65%	134,700/gal	12.09
	"	75%	"	10.48

Table 4.

Estimated materials and costs for a 20-square foot insulated Roman shade.

Material	Amount	Unit Cost (1984)
Face fabric (Chintz)	3 yds.	$2.50-4.50/yd.
Lining fabric	3 yds.	1.99/yd.
Polyester fiber-fill (2 layers)	40 sq. ft.	.14/sq. ft.
Cord	9.5-10 yds.	.15/yd.
Plastic rings 24	.04 each	
Slat rod	60"length	.13/ft.
Mounting board	1" x 2" x 60"	.11/ft.
Awning cleat	one	1.69

It is important to note that the same window treatment may not be appropriate for every home or every room in the home. Variety adds spice to life! What is best for you may not be the choice that someone else would make. The formula for calculating simple payback period is:

$$PB = \frac{\text{dollar cost of window treatment}}{\text{cost of heat saved each year}}$$

EXAMPLE

The Broken Bow family wants to know how long it will take them to save enough money on their heating bill to pay back the cost of putting in the insulating Roman shade.

To figure cost of the shade materials see Table 4.
For a 20-square foot shade the following materials costs are estimated.

$5.60 fiber-fill batting
2.00 plastic sheeting
6.00 lining fabric
7.50 face fabric
5.26 cord, cleat, rings, board for mounting, slat rod
$26.36 Total cost for shade and installation

Take the total cost and divide by the yearly savings to get the payback:

$$PB = \frac{26.36}{12.82}$$

$$PB = 2.05$$

The payback for this particular Roman shade is about two years. Remember that payback is always figured on the basis of current costs for fuel and price paid for the window treatment. If fuel costs rise, the payback period will be shorter.

Equations

1. Heat loss: $H = 24 \times HDD \times \text{U-value} \times ft^2$
2. Cost/million BTU's usable heat:
   $$\frac{(\text{cost/unit}) \times (1{,}000{,}000)}{(\text{BTU/unit}) \times (\text{\% efficiency})}$$
3. Cost of heat loss:
   $$\$ = \frac{H}{1{,}000{,}000} \times \text{cost/million BTU's available heat}$$
4. Payback:
   $$PB = \frac{\text{dollar cost of window treatment}}{\text{cost of heat saved each year}}$$

Adapted from FS776 Energy- Efficient Window Treatments, South Dakota State University, Cooperative Extension Service, 1983 with help from Rich Pierce, Ag Engineering Department, UNL.

ACTIVITY #6 RECYCLING FOR ENERGY

GRADE LEVEL

Elementary

TIME REQUIRED

3 - 5 Class Periods (50 Minutes)

RATIONALE

Recycling is the process of making items made of materials such as aluminum and paper available for re-use. Used cans, papers, bottles and other discarded items can often be processed and re-made into new products using energy at less cost than it would take to manufacture the same items from the original raw materials. It is a way in which each person can help conserve both energy and these valuable resources. Through recycling, the demand for virgin resources used by people and industry is reduced, thus conserving the finite supply of resources. Recycling saves energy in the manufacturing of new products; saves natural resources such as trees and coal; decreases the amount of land needed for landfills; and reduces dependence on foreign imports.

OBJECTIVES

1) Students will explain how recycling conserves materials and energy.
2) Students will list examples of reusable items.
3) Students will demonstrate how to recycle these items.
4) Students will identify the benefits gained by recycling.
5) Students will apply the economic decision-making model to recycling.
6) Students will research production processes of various goods and compare use of recycled to raw materials.
7) Students will study and define labor intensive and capital intensive production. They will then relate it to the recycling process.

CONCEPTS

Resource scarcity, conservation, recycling, energy efficiency, production and trade-offs.

STRATEGIES

Film "Trade-Offs" Series - Does it Pay?," "Learning and Earning," speakers, visits to recycling centers, lecture and application.

Exercise I: PENCIL SHARPENING ACTIVITY

MATERIALS

2 dozen pencils, stop watch, tools: pocketknife, hand pencil sharpener, crank pencil sharpener, electric pencil sharpener.

DIRECTIONS

1. Ask for five volunteers.
2. Assign four a "tool." Give each of them one minute to sharpen as many pencils as possible with their "tool." One person will not have a tool, but should also try.
3. Tally the pencils sharpened by each.
   a. Who sharpened the most? Why?
   b. Who sharpened the least? Why?
4. Explain that labor combined with capital goods (sharpeners) will increase labor productivity. Technology allows for more efficient use of capital goods. But also point out that it may require more energy resources to raise labor productivity. The electric sharpener may be faster than the hand crank, but may use energy resources unnecessarily, unless having sharp pencils in a hurry saves energy use somewhere else.

Exercise II: RECYCLING CAMPAIGN

DIRECTIONS

1. Show students what can be recycled. Refer to Handout #1 (you may want to ask them for ideas first.)
2. Start a recycling campaign in the school and/or community.
   a. Decide which items will be recycled.
   b. Determine the amount of recyclables your community and/or school probably generates.
   c. Investigate possible buyers for these items.
   d. Choose a goal for use of recycled funds. (One group bought flowers and trees for their town.)
   e. Can your goal be achieved through recycling activities? (Raise money, conserve natural resources?)
   f. Publicize your project.
      1) Put announcements in newspaper, radio, church, cafes, grocery stores, etc.
      2) Give information about recycling costs and benefits.
      3) Give instructions on how to participate in the recycling process.
   g. Decide how the items are to be collected. Possibilities include drop-off boxes, seasonal drives, curbside collections, designated area at landfill.
   h. Decide where and how items will be stored until they can be transported or picked up by the buyer.
   i. Present the results of your recycling project. This can be reported, verbally or written, to community and/or school personnel. The economics of starting a recycling business should be a major portion of that report.

Exercise II: COMPOSTING

DIRECTIONS

1. Choose a site where leaves, grass clipping, horse manure, etc. can be composted.
2. Arrange a system for pick-up of items or for drop-off site.
3. Investigate and plan a system for selling or distributing composted materials for use in gardens, fields, yards, etc.
4. Determine economic benefits of this process to the community.

Exercise III: SURVEY

DIRECTIONS

1. Have each student or group of students survey a business to find the quantity of paper, cans, oil, and/or glass it uses in a given period of time (week, month).
2. Questions that could be asked, in addition to others:
   a. What recyclable items does this business use? (paper, cans, oil, glass)
   b. How many of each item does this business use per time period?
   c. Who supplies these items?
   d. If you use paper packaging, why?
   e. Is there over-packaging of products? If yes, why?
   f. What percentage of the total cost of your product does packaging represent?

g. How do you dispose of your businesses' solid waste? (incinerator, landfill)
3. Students will tabulate results, prepare report, make recommendations based on survey findings.
4. Students will present reports to businesses they studied.

Exercise IV: RECYCLING USED OIL

DIRECTIONS

1. Students will determine the costs and benefits of collecting used oil, cleaning it, and making it available for re-use for heating, etc. The cost savings from preventing the environmental problems of "dumping oil" should be included.
2. Students will prepare a report summarizing facts gathered in Step 1.

Exercise V: DISCARDED ITEMS [1]

DIRECTIONS

Refer to Handouts #1, #2, #3 and #4.

1. Students will bring three discarded items from home or school that are recyclable.
2. Have students determine how these items could be recycled.
3. Determine trade-offs and/or opportunity costs of throwing away items versus recycling items.

Handout #1: PROJECTS

REUSE THAT JAR

Students ask friends, neighbors, and relatives how to reuse glass jars. Make a class list. Put copies of the list up in a local grocery store. Try making lists for other "waste objects."

OLD BAG ART

Decorate a bag with magic markers, paint or cut-outs and use it for a lunch sack. See how long you can make it last. Use old bags to cover school books. Decorate the covers.

RECYCLED PAPER

Recycling paper uses 50 percent less energy than making new paper. Each ton of paper recycled preserves an acre of harvestable trees. Make paper with your class. Use fabric scraps donated by parents to hand-stitch individual lunch bags. Use embroidery thread to sew on names. Cloth lunch bags can be washed.

CLASSROOM WASTE

At the end of a school day, sort through all the garbage in your class garbage can. Students discuss ways to reduce the amount of waste. Develop and implement a class waste reduction program. Trade garbage cans with another class.

1 "What Can Be Recycled," University of Nebraska- Lincoln.

Handout #2: WHAT TO DO WITH WASTE ITEMS

Solid Waste Item	Recyclable	Reusable
1. aluminum can	X	
2. aluminum pie pan	X	-can be used to bake in again -can be used for plant saucer -can be used as a pet dish
3. aluminum lawn chair	X	-can be fixed
4. apple core		-can be used in compost pile
5. bicycle tire		-can be fixed
6. book		-can be given to friend
7. bread		-can be fed to birds or ducks -can be used in compost pile -can be used for bread dough art -can be made into bread crumbs
8. cereal box		-cardboard can be used for art projects
9. clothes hanger		-can be used for wire -can be used in art projects -can be used to open up clogged drains
10. corrugated cardboard	X	-can be used to put things in -can be used to ship things in
11. cotton shirt	X	-can be used for rag -can be given to charity -can be mended -can be used to make rugs, dolls, or quilts
12. egg shells		-can be used in compost pile -can be used for Easter art projects
13. flowers		-can be used to plant seeds -can be used in compost pile -can be made in dried flowers
14. gift box & paper	X	-can be used in compost pile -can be used to store letters, toys, jewelry, shoes
15. glass bottle	X	-can be used for art projects
16. glass jar with lid	X	-can be used for bug jar, bank, terrarium
17. glass jug	X	-can be used for water, juice -can be used for terrariums
18. grocery sack	X	-can be reused for groceries -can be used for trash -can be used to wrap packages, cover books
19. leather shoes		-can be fixed -can be given to friend or charity -can be sold at garage sale
20. leaves		-can be used in compost pile -can be used in art projects
21. magazine		-pictures can be cut out for art projects -can be shared with friends -can be given to hospitals
22. mail		-can be used for scratch paper
23. margarine tub		-can be used as a container for leftovers
24. meat scraps		-can be used in compost pile -can be fed to pet dog or cat

Handout #2 (cont.)

Solid Waste Item	Recyclable	Reusable
25. milk carton		-can be used to make candles -can be used as plant containers
26. mirror		-can be used in bird cage -can be given to charity -can be sold at garage sale
27. newspaper	X	-can be used to wrap things -can be used to cover things when painting
28. nylon pantyhose		-can be used to make dolls or rugs
29. paper towel tube		-can be used for toy -can be used for arts and crafts projects -can be used to hold electrical cords
30. phonograph record		-can be given to friend or charity -can be sold at garage sale
39. wooden table		-can be fixed -can be used for firewood -can be given to charity
40. wool hat		-can be mended -can be given to charity -can be used to make rugs or afghans

Handout #3: WAYS TO HELP SOLVE SOLID WASTE PROBLEMS[2]

REVISE

-buy products without fancy packaging
-buy soft drinks in returnable bottles
-buy products with recycled symbol
-carry small purchases home without a bag
-buy products in one larger package
-buy products that will last longer or container instead of several small (durable pens, clothes, toys) ones
-buy fewer disposable paper products (paper towels, napkins, plates, cups)

REUSE

-give old clothes, toys, to charities
-sell old furniture, bikes
-use lunch sacks more than once
-return grocery bags to the store
-use grocery bags for trash sacks
-fix broken appliances, toys
-write on both sides of paper-use jars, boxes, plastic containers
-use disposable products like plastic again, before throwing away (cups, paper towels, and tin foil)

RECYCLE

-take newspapers to the recycler
-take tin cans to the recycler
-take glass jars and bottles to recycler
-take aluminum products to recycler
-take cardboard to the recycler
-take returnable bottles to the store

Handout #4: WHAT WILL I DO?

Things I can do to help
1. I can buy candy with less packaging.
2. I can reuse my lunch bags.
3. I can recycle aluminum cans.

Why should I do these things?
1. It will save natural resources.
2. It will reduce the amount of trash going to the landfill.

Why it may be hard to do these things
1. I really don't like the kind of candy with less packaging.
2. I have to remember to take my lunch bag home.
3. I have to carry the cans home from school and play.

Things I've decided to do
1. I probably won't buy the candy without extra packaging because I like the other better
2. I will reuse my lunch bag at least once.
3. I will save the aluminum cans I use at home.

2 "Reuse Stuff" Energy Activities for the Primary Classroom. California.

ACTIVITY #7 SOLAR GREENHOUSE FOR SCHOOL AND COMMUNITY

GRADE LEVEL

High School

TIME REQUIREMENT

2 - 4 Class Periods (50 Minutes) (Optional) Several months to build a greenhouse

RATIONALE

This activity provides students an opportunity to learn practical skills, to be exposed to new ideas and technologies, and give presentations on weather stripping, insulation, and other conservation techniques to peers and community members. The greenhouse also could serve as a laboratory for science, biology, and home economics classes in plant management, energy management, and various other subject areas.

Through the activity of designing solar greenhouses, students will identify the use of a non-polluting energy source that will not deplete the nation's resources. Also, the money spent to implement the greenhouse savings will be energy costs for the school.

OBJECTIVES

1) Students will demonstrate how a passive solar system works through the solar greenhouse.
2) Students will list the positive externalities of a solar greenhouse.
3) Students will list energy resources and explain the eventual scarcity of fossil fuels and relative availability of solar energy.
4) Students will estimate the energy and money that could be saved by the school, thus explaining the economic efficiencies of the solar greenhouse.
5) If the project is completed, students will chart and then compare the budgets with and without a green house to demonstrate the money saved.
6) If the project is completed, students will demonstrate how the heat produced by the solar greenhouse is used by the school.
7) Students could prepare and give demonstrations on plant management, plant identification, and plant processes through the solar greenhouse laboratory.
8) Students will use a decision-making grid evaluating trade-offs of building the greenhouse versus continuing without it.

CONCEPTS

Decision-making, investment, costs and benefits, production factors, renewable resources, solar energy, alternative energy, passive solar application, heat transfer, ventilation, humidity control, glazing, specialization of labor, trade-offs and externalities.

STRATEGIES

Films, speakers, short lecture, models and simulations, research and reading, oral presentations, hands-on application and field trip to a commercial greenhouse.

BACKGROUND LESSON AND EXERCISES

Investment is more than putting money in a bank to earn interest. When one deposits money in the bank, he or she is actually saving rather than investing. Because people do not spend all they earn and save some of it, the savings of many people create a pool of funds so others can invest in buildings, machinery, education, and other goods and services to make our economy more productive.

An investment occurs when someone thinks the long range benefits are worth the costs involved (remember the term opportunity cost). Investments in energy operate the same way. It may be for exploration of a new well, research in energy conservation, or the purchase of new machinery for a new type of energy technology. When solar energy was an infant, those who researched and produced solar equipment made investments of their education and resources in the belief that some day the benefits would far exceed the costs.

As you prepare to erect your solar greenhouse, remember to consider the opportunity costs (trade-offs), and the long term benefits versus your short term costs. Good luck.

Exercise I: COST/BENEFITS OF SOLAR ENERGY

Students will use decision-making grid to list cost/ benefits of solar energy.

Alternatives	CRITERIA
Solar	
Fossil Fuels	
Nuclear	

Exercise II: POSITIVE EXTERNALITIES OF SOLAR GREENHOUSE

Students will list positive externalities of a solar greenhouse.

Positive Externalities

1. use in various classes for experiments
2. energy efficiency
3. flower sale with proceeds used by school
4. beautification
5. used by community
6. grow food to give to community food bank or senior citizens

Exercise III: SOLAR GREENHOUSE DESIGN

Give students a copy of HANDOUT #1

Have each student develop a non-technical design to add a solar greenhouse to your school. Students should explain where they would build it, and why. Also, students should include a non-technical drawing of the design of their greenhouse, and explain what activities they would like to see happen in their greenhouse. Encourage imaginative application and stress that the idea is more important than a technical blueprint. (A mechanical drawing class could draw the ideas supplied by other students in a joint project.)

TEACHERS' BACKGROUND

A solar greenhouse attached to your school building provides a unique activity in which many students can become involved. Construction, FFA, or industrial arts classes can build the structure; mechanical and architectural drawing classes, home economics classes, and/or science classes can design insulation shutters and solar panels; accounting classes outline the project budget and organize the data; art classes design the greenhouse color scheme, interior design, and windows; the language arts classes write the public relations announcement informing the community of the goals and progress of the project through news-release and/or a newsletter; economics classes research and determine the energy and economic savings, economic investment, costs and benefits, and the payback for such a project; history classes graph historical change in energy use; and business classes can research the process of acquiring outside funding to implement the project.

Greenhouses are a relatively inexpensive way to add space to older buildings. The properly designed greenhouse will add heat to the building and provide an opportunity to supplement the food supply of the occupants of the building.

Ideally, greenhouses should face south for maximum exposure to the sun. Windows or vents at the upper and lower parts of the building wall allow entry and circulation of fresh, warm air which collects in the highest parts of the greenhouse. Ventilation to the outside and shading overhangs should be provided to prevent the greenhouse from becoming overheated in the summer.

The most common glazing materials for greenhouses are glass, fiberglass or plastic. Insulation of the glazing plus thermal mass in the form of water-filled containers, masonry support structures, rock or slab floors, or a combination of all these elements, must be used inside the greenhouse. In temperate climates a single layer of glazing is all that is necessary. In more severe climates, double glazing and insulation may be necessary during sunless periods. Thermal mass and insulation of the glazing help control the wide fluctuations in temperature which may otherwise occur.

A solar greenhouse establishes a thermal "buffer zone" which can substantially reduce heat losses. The effectiveness of any solar energy system depends upon its environment.

Each building site may have its own set of circumstances. To optimize a natural space conditioning system, detailed data on each site must be gathered and analyzed.

Daily, monthly, and seasonal solar radiation patterns must be evaluated to make sure that sunlight is available when required. Wind direction and strength must be considered, as well as precipitation. The site should also provide for the adequate drainage of water.

Slopes may help or hinder. A south-facing slope provides the most solar exposure and a northern slope the least. A west-facing slope warms the building in the afternoon, and an eastern slope takes advantage of morning sunshine. Some slopes may also shade the structure during parts of a day, month, or season.

The size, variety, and location of trees and plants must be arranged so that solar collection is possible.

In a passive solar greenhouse, a reflecting surface directs heat from the sunlight towards the plants at the base of the greenhouse. The concrete base would absorb heat and radiate this into the greenhouse when the greenhouse starts to cool during the evening. Some solar greenhouses have black storage drums filled with water along the north wall to absorb the sun's heat and radiate the heat at night. Passive systems, as you know, use the building and landscape to collect, store, and transfer solar heat.

Attaching a solar greenhouse to the south wall of a building is a way to gather extra solar heat for the building, while growing plants for educational use.

Solar energy is plentiful, harmless, and free so it makes good sense to use it. Using solar energy allows for the reduction of fuel bills, while helping to solve our many energy problems.

What follows is an ENERGY FACT SHEET ON SUNSPACES AND SOLAR GREENHOUSES, produced by the U.S. Department of Energy. Also included in this activity is a SOLAR GREENHOUSE BIBLIOGRAPHY AND LIST OF PLANS for additional information for the classroom.

SOLAR GREENHOUSE FOR SCHOOL AND COMMUNITY

Note to educators: The cost of building this system can be prohibitive, although results are substantial and beneficial. Programs like this can sometimes be funded by outside sources. It you want to try this project, perhaps a study on outside funding can be added to the lesson as an educational activity.

Sunspaces and Solar Greenhouses

Either as an addition to an existing home or an integral part of a new home, sunspaces have gained considerable popularity.

The attraction of the sunspace is its adaptability. Its design, construction, and use involve a wide range of options, which can be combined to meet many tastes, needs, and budgets.

This factsheet focuses on the sunspace as a home heating system. (It is also usually used as living space or for growing plants and vegetables.) The featured design, shown here and on page three, is primarily an efficient solar heat collection, storage, and distribution unit intended as an addition to an existing house. A sunspace for a new building might be similar in design, but it would be constructed as part of the original building rather than added on.

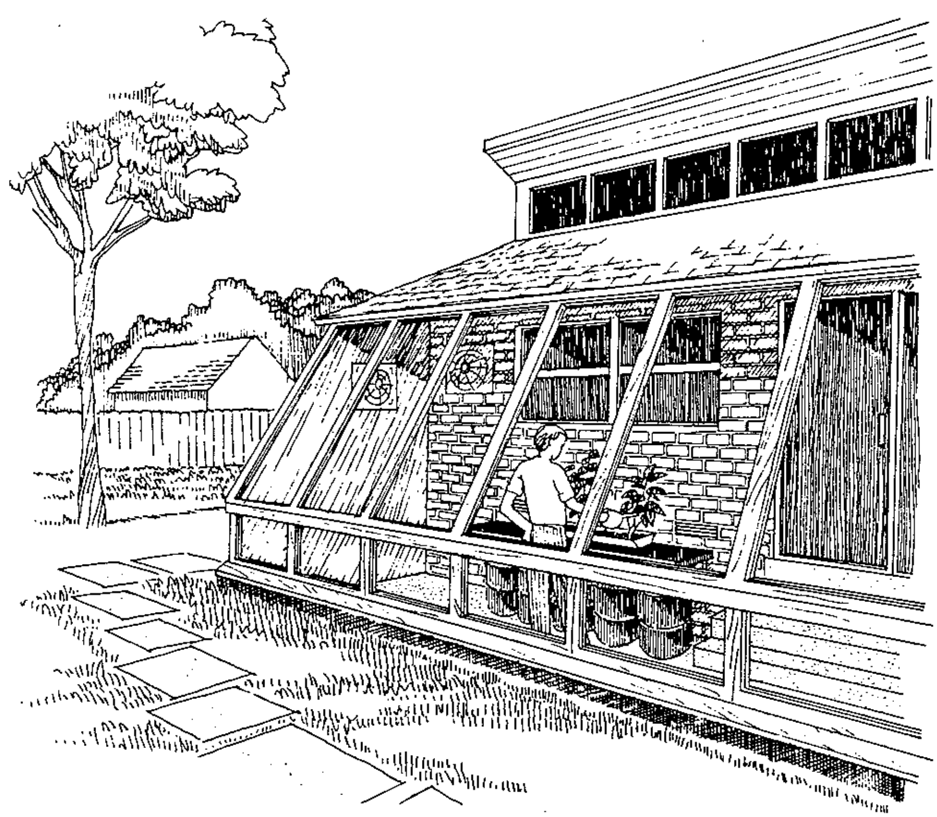
How It Works

A greenhouse should face within 30° of true south. In the winter, sunlight passes through the windows and warms the darkened surfaces of the concrete floor, brick wall, water-filled drums, or other storage mass. Some heat is absorbed into the thick concrete, brick and water, where it remains stored until the indoor temperature begins to cool, after the sun sets. The heat not absorbed by the storage elements can raise the air temperature inside the sunspace, during the day, into the 90° to 100° Fahrenheit range. As long as the sun shines, this heat can be circulated into the house by natural convection or drawn in by a low horsepower fan.

At sunset, sunspace windows should be covered with movable insulation to control heat loss. A sunspace will remain warm as long as it can draw on the heat in its storage elements and the house (in the example) will also be warmed by the common brick wall it shares with the sunspace. The storage elements will continue to supply heat until they are the same temperature as the air in the living space.

Five Passive Solar Elements

Any sunspace must include the following elements in order to be considered a complete passive solar heating system:



1 Sunspaces and Solar Greenhouses. Solar America, Inc., and the Franklin Research Center for the U. S. Department of Energy. P.O. Box 8900, Silver Spring, MD 20907.

HANDOUT #2

1. A collector, such as the double layer of greenhouse window glazing (glass or plastic).

2. An absorber, usually the darkened surfaces of the walls, floors, and water-filled containers inside the sunspace.

3. A storage mass, normally the concrete, brick, and/or water that retains heat after it has been absorbed.

4. A distribution system, which is the means of getting the heat into and around the house; i.e., fans, and/or natural convective flows.

5. A control system, (or heat regulation device), such as the movable insulation used to prevent heat loss from the sunspace at night. Roof overhangs that block the summer sun and thermostats that activate fans are also controls. Some controls are operated by occupants.

All five of these elements must work together.

The Attachment: Some Options

One of the more important questions to consider when designing a sunspace is how it will be attached to the house. The following four options demonstrate the adaptability of the sunspace concept:

Option 1: The sunspace is separated from the main structure by an uninsulated brick, block, or concrete wall. This wall will absorb and store solar heat that will, over a period of several hours, migrate through the wall; most of it reaching the main living space later in the day and after the sun has set.

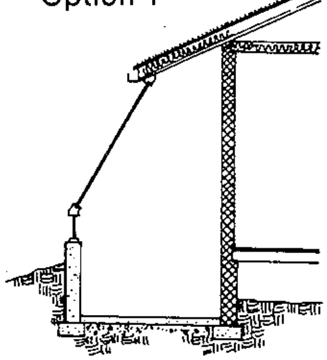
Option 2: The sunspace is separated from the main structure by sliding glass doors and stationary "door-size" windows. Behind the stationary windows, inside the living space, are tall water-filled tubes. Sunlight passes through the sunspace, then through the stationary windows, and strikes the water tubes. These absorb and store heat for later use. (If the tubes are spaced apart, the room also receives direct sunlight for immediate warmth.)

Option 3: As in Option 2, the sunspace is separated from the main house by oversized windows and sliding glass doors. However, instead of water tubes, the sunlight strikes the masonry floor of the living space. The floor should be at least four inches thick (typically, a concrete slab covered with ceramic tile or brick) and left uncarpeted (carpeting will prevent heat absorption).

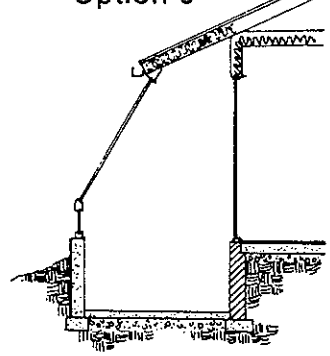
Option 4: There is little or no separation during the day between the sunspace and the main living space. Sunlight and heat pass directly and easily through the sunspace to the main structure. At night, movable insulation will be required either to cover the sunspace glazing or seal off the main structure from the sunspace.

A combination of these options may be the best overall approach. In any case, these are only a few of the things that ought to be considered when designing and building a sunspace.

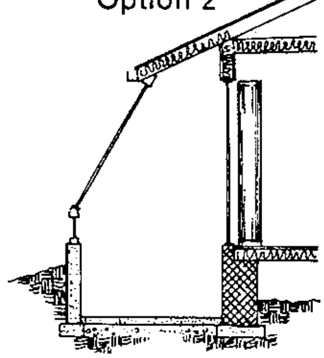
Option 1



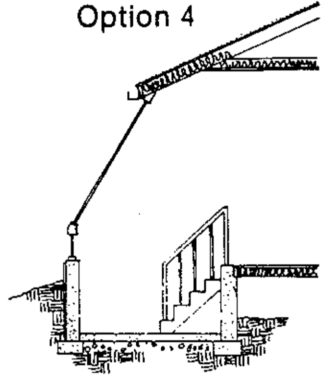
Option 3



Option 2



Option 4



More Design Considerations

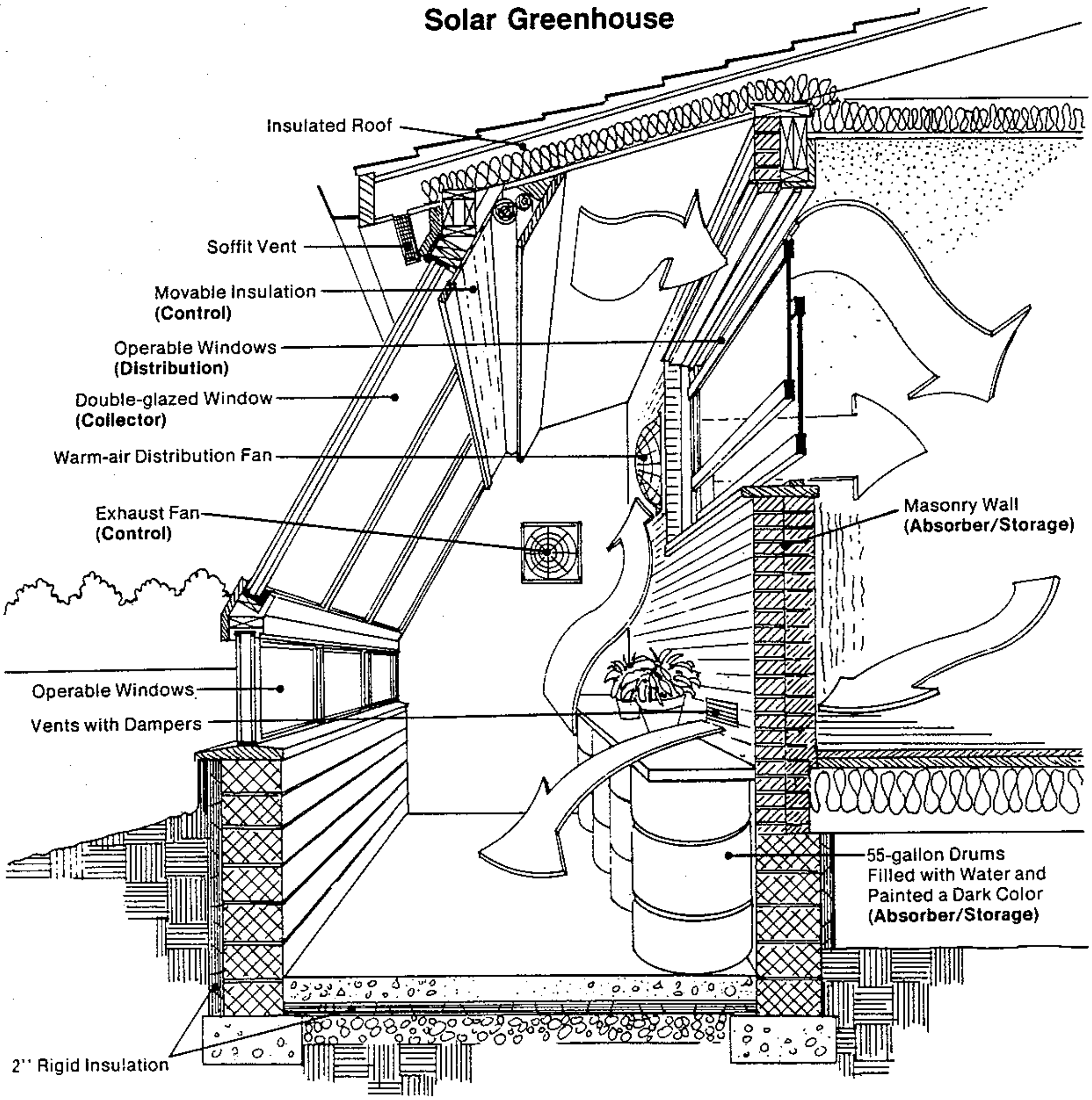
The illustration below shows some other important design points. First, this sunspace has an insulated roof. If the roof were glass, as it is in many conventional greenhouses, much more heat would be lost because heat rises and accumulates near the roof.

Glass provides very little resistance to the conduction of heat back outdoors. The endwalls are solid, not glazed, and are also insulated.

The glazing in this illustration is tilted to allow the maximum amount of solar radiation to reach the greenhouse during the winter months. The recommended angle of tilted glazing is equal to the latitude plus 15 degrees, although any tilt in the range of 45 degrees to 60 degrees works quite well for most locations in the continental United States.

Recent performance results and experiences with sunspace designs indicate that vertical glazing works better than or just as well as tilted glazing in most parts of the country. While using vertical glazing will reduce incoming solar radiation somewhat (10 to 20 percent in northern states, 20 to 30 percent in southern states), the advantages often outweigh the loss in efficiency. First, vertical glazing is easier to seal, particularly for do-it-yourselfers. Also, summertime overheating is reduced if vertical glazing is used, because the brighter summer sun cannot enter vertical glazing as easily as tilted glazing. The heat loss rate of tilted glazing is greater than that of vertical glazing, due to the upward direction of heat flow and night sky radiation loses. Finally, movable insulation can be applied more easily to vertical glazing.

Solar Greenhouse



2 Path to Passive. U. S. Department of Energy. Grant # DE-FG47-80CS69109.

Reducing Heat Loss

When the sun sets, the window through which heat has been efficiently collected during the day becomes a problem. Without the sun's incoming energy, the flow of heat back through the glass at night may result in losses greater than the daytime solar gain. It is important to block these night losses.

Movable night insulation, in one form or another, is the solution. Most solar researchers agree that night insulation will substantially improve the performance of the sunspace as a solar heat collector. There are now several types of movable insulation on the market. Movable insulation can also be built on site with easily purchased materials.

Another option for reducing heat loss is to use special glazing units that incorporate transparent films or insulation materials into the unit. The cost of such units is usually comparable to the combined cost of standard glazing units and movable insulation.

How Much Heat Can Be Provided to the Home?

This depends on the square footage of the sunspace window (i.e., collector), local clumate conditions, how tightly the sunspace is built, whether or not night insulation is used, and how well the solar heat is drawn from the sunspace into the house. Results from monitoring of passive homes indicated that well-designed sunspaces can provide 40-60 percent of the heating requirements during the winter.

It is not inconceivable that in climates with sunny winters, a very large sunspace – with a window collector area equal to at least one-fourth of the floor area of the house – could supply 75 percent of the heating required. A percentage this high could be achieved only in a house where all possible energy conservation measures have been taken so that the heating required has been drastically reduced. These measures include thorough weatherstripping around doors and windows, caulking around door and window frames and other construction joints, adding insulation to the attic and walls, and adding storm windows and doors.

In the Summer

Sunspaces, unfortunately, become even better solar collectors during the summer when cooling is the problem. It is necessary, therefore, to keep sunlight out of the sunspace and to vent the heat that accumulates. The same movable insulation used to prevent heat loss on winter nights can be used to prevent heat gain on summer days. Retractable awnings or reflective shades are other choices. For venting heat, the sunspace design shown here uses an exhaust fan. This can be turned on by hand or activated by a thermostat. Many sunspaces have operable roof vents that allow heat to escape.

A "Hybrid" Sunspace

A sunspace can be linked to a remote rock storage bin. Heat is ducted from the sunspace to the rock bin with the help of fans and blowers. The rocks absorb and store the heat until it is needed. The bin should be located under the part of the house you want to heat, unless you want to heat the sunspace at night in which case the bin should be located under the sunspace.

Adding a rock storage bin to a sunspace increases the cost and can decrease the overall thermal performance of the system. The thermal mass of the sunspace should be reduced in order to allow more heat to be ducted to the rock bin.

Growing Plants in the Sunspace

If plants or vegetables are grown, this must be balanced with the heating function of the sunspace. The sunspace cannot be used to its full heating capacity if large numbers of plants are grown in it. Plants require fresh air and high humidity, and the evaporation cycle of the plants uses energy. Many plants cannot tolerate the high temperatures and temperature swings that occur in sunspaces designed for heating. The use of plants in sunspaces designed primarily for heat should be limited to a small number of plants that can tolerate the conditions of the sunspace.

Construction

Some homeowners prefer to do construction themselves, others prefer having it done for them. Some have their sunspaces custom-built; others buy packaged assemblies.

The design presented in this fact-sheet is principally a tight solar heater; it can be adapted to both new and existing buildings. It can be built to whatever size and specifications are required. The cost of a sunspace depends on the overall design, the materials used, and the need for passive systems. Going below or above this range is quite possible, with do-it-yourself projects lowering costs and custom-designed and built sunspaces increasing them.

HANDOUT #4[3]

Solar greenhouses (or sunspaces) have become one of the most popular means of harnessing solar energy. This is probably due to their versatility. A solar greenhouse can collect solar energy to help heat your home. Or, it can be used for growing plants and vegetables. A solar greenhouse also adds another room to a home - a room that's often sunny, cheerful, and therefore very inviting.

This bibliography lists a variety of solar greenhouse publications. Many articles, and books on passive solar energy in general, also discuss solar greenhouses.

Books and Pamphlets

These are non-technical except where noted otherwise.

BUILD A SOLAR GREENHOUSE... New Mexico Energy Institute, New Mexico Energy and Minerals Department; 525 Camino de los Marquez, Santa Fe, NM 87502, 1982 (rev. edition), 13 pp, free. Provides a general introduction to solar greenhouses. Gives step-by-step instructions for building a typical attached greenhouse.

THE COMPLETE GREENHOUSE BOOK... P. Clegg and D. Watkins; Garden Way Publishing Co., Charlotte, VT 05445, 1978, 280 pp, $10.95. Tells how to evaluate and choose between greenhouse designs. Gives building details. Also presents the history of the greenhouse.

THE FOOD AND HEAT PRODUCING SOLAR GREENHOUSE... B. Yanda and R. Fisher; John Muir Publications, P.O. Box 613, Santa Fe, NM 8750l, 1980 (rev. edition), 208 pp, $8.00. Covers both greenhouse construction and food production. Presents some state of the art examples.

GROWING FOOD IN SOLAR GREENHOUSES... D. Wolfe; Dolphin Books, Doubleday and Company, New York, NY 10167, 1981, 192 pp, $10.95. Based on the premise that greenhouse gardening is different from outdoor gardening. Tells you what to plant for each month of the year.

LOW-COST PASSIVE SOLAR GREENHOUSES... National Center for Appropriate Technology, P.O. Box 3838, Butte, MT 59702, 1981 (rev. edition), 176 pp, $6.00. A guide to designing and building solar greenhouses for both food production and home heating. Written for the experienced do-it-yourselfer and more technical than the other books and pamphlets listed.

THE SOLAR GREENHOUSE BOOK... J.C. McCullagh, ed.; Rodale Press, Emmaus, PA 18049, 1978, 328 pp, $10.95. A comprehensive primer on greenhouse design, construction, and gardening.

SOLAR GREENHOUSES FOR MOBILE HOMES... N. Werthman: Sunspaces, 2520 Sacramento Street, San Francisco, CA 94115, 1980, 24 pp, $2.75. Guidelines for designing and building an attached greenhouse for a mobile home.

SOLAR GREENHOUSES: UNDERGROUND... D. Geery; Tab Books, Blue Ridge Summit, PA 17214, 1982, 408 pp, $12.95 (paperback). Design and construction details for building a solar greenhouse underground. Intended use of greenhouse is for growing plants not for producing heat.

THE SOLARIUM WORKBOOK... Hawes and Wight Ltd. and the Brace Research Institute; National Research Council of Canada, Building R88, Ottawa, ON KIA OR6, 1982, 112 pp, $14.95. How-to-guidebook for sunspace design and construction.

SOLARSPACES... D. Strickler; Van Nostrand Reinhold, New York, NY, 1983, (paperback). Descriptions and photographs of various sunspace designs.

3 Solar Greenhouses and Sunspaces. Solar America, Inc., and the Franklin Research Center for the U. S. Department of Energy. P.O. Box 8900, Silver Spring, MD 20907.

SOLPLAN 3 - SOLAR GREENHOUSES FOR CANADA... R. Kadulski, E. Lyster and T. Lyster; The Drawing-Room Graphics Services Ltd., P.O. Box 86627, North Vancouver, B.C., V7L 4L2, 1980, 60 pp, $4.50. Provides information on constructing and managing energy efficient greenhouses in northern climates.

Proceedings (Technical)

PROCEEDINGS: FOURTH ANNUAL CONFERENCE ON SOLAR ENERGY FOR HEATING GREENHOUSES AND GREENHOUSE-RESIDENCE COMBINATIONS...D.R. Mears; Piscataway, NJ, April 1-4, 1979, 214 pp, $20.00. Available from Cook College, Rutgers University, P.O. Box 213, New Brunswick, NJ 08903. Provides findings of research conducted on greenhouse solar heating and commercial demonstration projects.

THIRD ANNUAL CONFERENCE ON SOLAR ENERGY FOR HEATING OF GREENHOUSES AND GREENHOUSE-RESIDENCE COMBINATIONS... U.S. Department of Energy; Fort Collins, CO, April 2-5, 1978, 117 pp, $7.50. Available from Solar Energy Applications Laboratory, Colorado State University, Fort Collins, CO 80523. Similar to above document.

Reports, Papers and Bibliographies (Technical)

ATTACHED SUNSPACE HEATING PERFORMANCE ESTIMATES... R.W. Jones and R.D. McFarland; Fifth National Passive Conference, Amherst, MA, October 19, 1980, 6 pp, $5.00. Report No. LA-UR-80-2236, available from NTIS (see Source List). Describes how variations in the design of attached sunspaces affect heating performance.

ATTACHED-SUNSPACE PASSIVE SOLAR-HEATED RESIDENCES: A STUDY OF NATIONWIDE PATTERNS OF ECONOMIC FEASIBILITY FOR THE EXISTING HOUSING STOCK... F. Roach and C. Kirschner; Los Alamos National Laboratory, 1981, 135 pp, $13.50. Report No. LA-8889-MS, available from NTIS (see Source List). Uses performance estimates to analyze the economic performance of a retrofitted sunspace.

PASSIVE SOLAR HEATING OF BUILDINGS WITH ATTACHED GREENHOUSE — PROGRESS REPORT FOR FEBRUARY 29 - APRIL 29, 1980... R.W. Jones; University of South Dakota, 1980, 28 pp, $6.50. Report No. DOE/CS/30242-3, available from NTIS (see Source List). Describes progress made during the third quarter of a research project. Gives performance estimates for some types of attached greenhouses built in the north-central region.

QUICK BIBLIOGRAPHY SERIES — GREENHOUSE ENERGY CONSERVATION 1975 - 1979... U.S. Department of Agriculture, Reference Branch, Technical Information Systems, Science and Education Administration, National Agricultural Library, Beltsville, MD 20705, 1980, 38 pp. free. Contains about four hundred citations derived from various data bases.

Greenhouse Plans

ADD-ON GREENHOUSE PLAN... New York State Energy Research and Development Authority, 2 Rockefeller Plaza, Albany, NY 12223, $18.00. Construction manuals and working drawings for an attached solar greenhouse and a sunspace addition.

ATTACHED SOLAR GREENHOUSE CONSTRUCTION GUIDE... New Mexico Solar Energy Association, P.O. Box 2004, Santa Fe, NM 97501, $6.95. Guide for building two designs: straight-eave and Quonset.

FREE-STANDING SOLAR RELIANT GREENHOUSE PLANS: No. BP 042... Solstice Design Inc., (see Source List), $18.00. Five 18 inch by 24 inch blueprints for a free-standing 12 x 16 foot greenhouse.

LARGE COMMERCIAL PASSIVE SOLAR GREENHOUSE PLANS: No. B4044... Solstice Design Inc., (see Source List), $45.00. Eight 24 inch by 36 inch blueprints for a 5000 square foot solar commercial/community greenhouse.

PLAN FOR THE CONSTRUCTION OF A BRACE GREENHOUSE: No. 2-T.101... Brace Research Institute, (see Source List), $2.50. Plan and construction details for a 20 x 20 square foot wood-frame greenhouse.

PLAN FOR THE CONSTRUCTION OF THE LATEST MODEL OF THE BRACE DESIGN GREENHOUSE: THE EXPERIMENTAL NIGHT-COVER GREENHOUSE: T.110... Brace Research Institute, (see Source List), $2.50. Diagram illustrating Brace-type greenhouse that incorporates underground heat storage and an insulating night cover.

SINGLE STORY ATTACHED PASSIVE SOLAR GREENHOUSE PLANS: No. BP 039... Solstice Design, Inc., (see Source List), $22.00. Eight 18 x 24 inch blueprints for an attached solar greenhouse.

SUN HAUS GREENHOUSE/SOLARIUM CONSTRUCTION, OPERATION MANUAL, AND SET OF BLUEPRINTS... Weather Energy Systems, Inc., 39 Barlows Landing Road, Pocasset, MA 02559, $50.00. Detailed blueprints and manual for an insulated greenhouse with heat storage and automatic ventilation system that transfers heat from the greenhouse into the house.

SUN FLAKE SUN ROOM... R. Feeney, P.O. Box 1698, Durango, CO 81301, $16.22. Blueprints for sunroom utilizing Sunflake combination window unit. Vertical wall design.

SUNSPACE BLUEPRINTS... J. Coleman Building and Design, Box 45, Moss Hollow Road, Marlboro, VT 05344, $25.00. Blueprints for attached sunspace.

SUN-TEL SUNSPACE MANUALS... Sun-Tel, 1270 Parrish Street, Lake Oswego, OR 97034, $17.50. User's manual, construction manual, and three blueprints for a vertical wall sunspace you can build from off-the-shelf materials.

THE UNIVERSAL RETROFIT PASSIVE SOLAR GREENHOUSE: No. B4041... Solstice Design Inc., (see Source List), $35.00. Ten 18 inch x 24 inch blueprints for an attached greenhouse designed to fit any one, two, or three-story house.

VEGETABLE FACTORY GREENHOUSE SAMPLER KIT... Vegetable Factory, Inc., P.O. Box 2235, Grand Central Station, New York, NY 10017, $10.00 (refundable upon return or purchase of greenhouse kit). Assembly plan, operation manual, and material samples of a greenhouse kit (including solar panel sample).

This is not a complete listing of available greenhouse plans. You may also wish to check magazines such as Rodale's New Shelter, Solar Age, or Mother Earth News. These periodicals sometimes contain advertisements for solar greenhouse plans.

Source List

Brace Research Institute
MacDonald College of McGill University
Ste. Anne De Bellevue
Quebec, Canada H9X ICO
(include $1.50 handling charge)

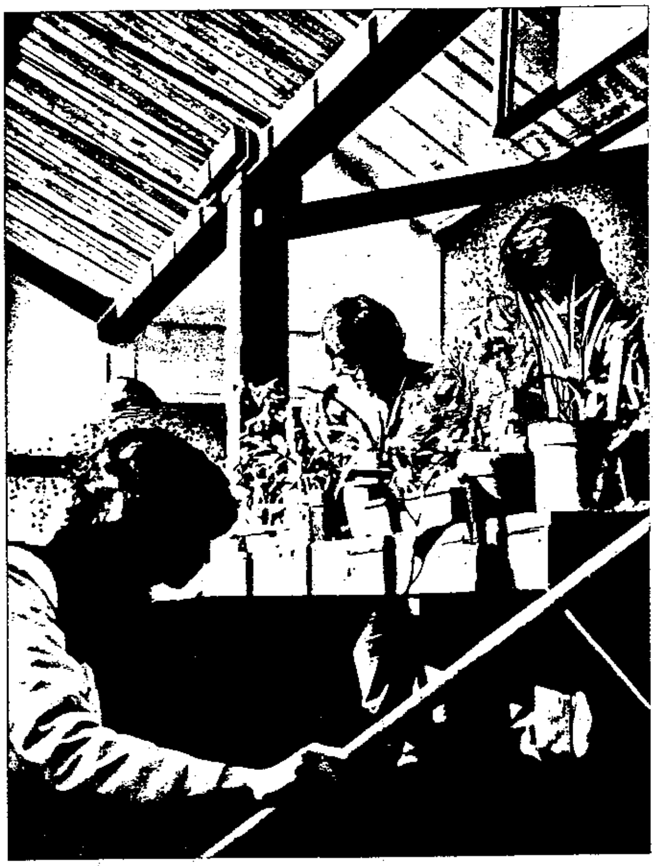
NTIS
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Solstice Design Inc.
P.O. Box 2043
Evergreen, CO 80439
(include $3.50 for first-class postage, handling and insurance, or $1.50 for fourth-class postage)

HANDOUT #7[4]

STUDENTS TEACH, COMMUNITY LEARNS

Photo by Barbara Miller



Horticultural classes teach basics of plant management.

The students at Juanita High School in Kirkland, Washington, are understandably proud of their solar greenhouse. Designed by students in Thomas Short's advanced architectural drawing class, the greenhouse design won the grand prize for excellence at the Energy 2000 high school conservation fair. It was also awarded a $21,000 grant from the Department of Energy which, along with matching funds from the Lake Washington School District, made it possible to turn this award-winning design into a working reality. And a working classroom.

From the beginning, everyone at the high school was involved in the solar greenhouse project. While the construction classes were building the structure, the mechanical and architectural drawing classes (with assistance from the science classes) were designing insulating shutters and solar panels, the accounting classes were keeping the project's books, the graphic art classes were designing the building's color scheme and stained glass windows, and the language arts classes, acting as a press corps, were informing the community about the goals and progress of the project. Even a "rival" high school participated, printing business cards, stationery, envelopes, and a greenhouse newsletter.

The result was a unique educational experience in which students worked together to achieve a goal. And in the process they have learned how to be teachers themselves, sharing information in the classroom and making presentations in the community.

The greenhouse project offered all students an opportunity to participate in a project that not only taught them practical skills and exposed them to new ideas and technologies, but also to become better scholars—to give presentations on insulation, weatherstripping, and other conservation techniques to fellow students and to members of the community, to develop a low level science class entitled "Energy, Food, and You," and to plan an extensive community education program.

With the greenhouse completed they have turned their attention to construction of models of conventional walls, energy efficient walls, and superinsulated walls to use in presentations. Their educational package will include thirty of each model to display when they make presentations to other students, civic groups, or professionals in the building trades.

Not only has the greenhouse project and the students' educational programs made a new technology available to everyone, but as the instructor put it, "The greenhouse has given everyone, no matter what their skills or academic level, a chance at success."

4"Energy Fact Sheet," Sunspaces and Solar Greenhouses. Nebraska Energy Office.

Nebraskans have always tended to be an independent lot, they seem to want to face things squarely. To solve their own problems. The energy problem is no different. The desire to make a change is there. The only question has been how to do it. Now, people are finding they have the answers.

In 1978, the U.S. Department of Energy began a new program called the Appropriate Technology Small Grants Program. This program solicited ideas and funded projects that used conservation, solar power, and other innovative measures to reduce energy use. The hallmark of these projects lies in their utilization of local resources and skills to solve a local energy problem. The projects tended to be people-oriented, more labor intensive technologies that hold the promise of providing permanent, new energy sources now and for generations to come.

ENERGY THE ANSWERS ARE HERE

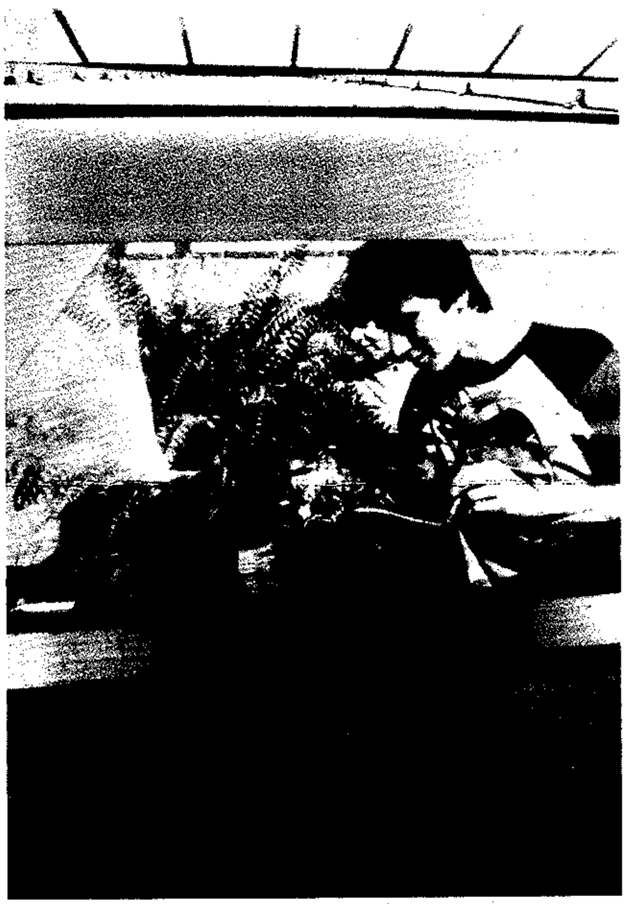
Solar Greenhouse

In Crete, Nebraska, Mick Morton, a teacher at the Crete Junior/Senior High School had an idea for creating a solar greenhouse as an educational laboratory and a supplemental heat source. So they applied for an Appropriate Technology grant to build a solar greenhouse on the southside of the Crete Junior/Senior High School. The solar greenhouse was constructed as part of the academic program for Industrial Arts Classes and currently serves as an educational facility for classes in biology, chemistry, and physics.

The structure is located on the south side of the Crete Junior/Senior High School located at 1500 East 15th Street, Crete, Nebraska. The solar greenhouse utilizes ice-clear acrylic fiberglass reinforced panels on an aluminum frame. The panel area provides 1500 square feet of absorption area and covers a ground area of 925 square feet. It is recommended that when you are sizing glazing area of your solar greenhouse, the ratio of glazing area per square foot of floor area should be .78-1.3 sq. ft. if the building material between the sunspace and living space is masonry wall.

Ventilation and humidity control are two critical factors in the operation of a solar greenhouse. A 'rule of thumb' is that approximately one-sixth of the floor area size should be the amount of absorption area devoted to movable ventilation panels. One set of vents should be located at 'knee high' level on the solar greenhouse to allow for air flow and another set of vents should be located at the uppermost part of the solar greenhouse in order that excessive hot air can be expelled. Sixty per cent relative humidity is ideal. Ventilating fans should be sized at 5cfm per square foot of south glazing.

Storage of heat captured by the solar greenhouse is another important greenhouse operating factor. The Crete Junior/Senior High School is made of brick, a very good storage medium. In addition, students painted 55 gallon oil drums black and filled them with water. This has been found to be a very successful storage medium for solar heat. If a thermal wall is a chief heat transfer mechanism between the greenhouse and the inner house, wall thickness should reflect the following: 10″-14″ for brick, 12″-18″ for concrete, or 8″ plus for water or 0.16 cubic feet per square foot of south glazing.



Botany students at Crete Junior/Senior High School have discovered several important solar greenhouse operating principles: ventilation will provide needed carbon dioxide to plants, plants can not tolerate more than a 10°-15° F fluctuation;, night shutters and auxiliary heat may be required, rockbed or water container storage will maximize solar heat gain and plant production.

If you would like more information about solar greenhouses, we recommend the following literature: *Solar Greenhouses: Lessons Learned After Five Years* by the National Center of Appropriate Technology, and *The Path to Passive, Nebraska's Passive Solar Primer,* by Solar Energy Associates, both are available through your Nebraska Energy Office.

Should you be interested in reading more about Appropriate Technology we recommend reading the following books, all available from your Nebraska Energy Office.

Appropriate Technology At Work

Waste to Resources: Appropriate Technologies for Sewage Treatment and Conversion

Drying Wood with the Sun: How to Build a Solar Heated Firewood Dryer

Supplying Supplemental Combustion Air for Gas-Fired Appliances

Solar Greenhouses: Lessons Learned after Five Years

Heat-Recovery Ventilation Systems for Energy-Efficient Houses

Major Energy Conservation Retrofits: A Planning Guide

Home-Made Electricity: Wind, Micro-Hydro, and Photovoltaics

Home Window Insulation Treatments: What to Look for When Choosing a Design

Methane: A. T. Small Grants—A Technology Overview

ACTIVITY #8 ECONOMICS OF ENERGY FAIR

GRADE LEVEL

Upper Elementary, Middle Grades, High School

TIME REQUIRED

2 - 4 Class Periods (50 Minutes); Several weeks for Energy Fair

RATIONALE

An Economics of Energy Fair is a means of presenting to people an overview of energy sources and issues through various models, charts, demonstrations, and exhibits. It is an excellent way to educate people about their community's energy problems and opportunities. A fair gives people the opportunity to find out how broad their energy choices are for today and tomorrow's energy challenges. Choices are the essence of our energy problems. Wise choices can only be made by citizens who understand the many issues of energy, including productions, consumption, and the environmental and economic impact of their energy decisions in the community.

OBJECTIVES

1) Students will experience the educational impact of an energy fair.
2) Students will demonstrate how to plan and organize an Economics of Energy Fair.
3) Students will investigate and research various energy issues.
4) Students will research the economic impact of their energy exhibits.
5) Students will gain an increased awareness of energy and economics within their own community. Essential information is needed by consumers, producers, and resource owners in a market system to decide what and how much to buy.

CONCEPTS

Economic information, economic decision-making, energy management and energy efficiency.

STRATEGIES

Mini-lecture, research, reading, application, group work and speakers.

Exercise I:
ORGANIZING AN ECONOMICS OF ENERGY FAIR

DIRECTIONS

1. Brainstorm for topics for the fair. Remember that topics include both written reports drawing to explain the report, a model, diagram, or simulation. This is an opportunity for students to become very creative.
2. Try to incorporate as many classes as possible in the fair. Art students can design the program, signs, and assist in posters. Math, science, and social studies students can prepare background data for exhibits and design charts and graphs for interpretation of data. English, writing, and speech classes can prepare news articles, public service announcements, newspaper ads, and interviews. Agricultural education students can give demonstrations on latest soil conservation methods and gasohol production.
3. Arrange the groups and choose the topics. Topic suggestions: weatherization, energy savings through recycling, local energy management, residential energy conservation, solar energy versus conventional energy sources, driver efficiency and car care, gasohol, wind energy, soil conservation, wind breaks, tree planning, energy audits, etc.
4. Explain the report and project requirements to each student. Understanding the components now can reduce problems later. It is important that the students know the expected format for their reports, due date of reports and project.
5. Have students write companies, etc. for information that will be of value to them in writing their reports and preparing their project.
6. Have students invite guest speakers to talk about energy and economic topics.
7. Arrange a schedule of events for Energy and Economics Fair Day, (i.e. students viewing of the fair, when it will be open to the public, publicity, etc.).
8. Invite public and parents by written invitation.
9. Students can prepare handouts for the fair that help explain their project. They can also have brochures from the utilities and other businesses available for distribution.
10. Set Up: Allow students time to set up before actual fair begins.
11. Evaluation: Keep log on activities, problems, responses.
    a. Devise a short evaluation form for fairgoers, parents, and teachers to fill out before they leave the fair. This can be very important feedback for you as you make plans for another fair.
    b. Take pictures.
12. Awards: Allow time to award individuals for their reports and projects.

The following forms in Handouts #1 - #5 may be used in the planning and organizing of your Economics of Energy Fair.

Handout #1:
ENERGY EXPO TOPICS

ENERGY TOPICS

Here is a list of possible topics for you to research. Look over the list carefully and discuss any questions with your teacher. Can you think of any other topics to add?

BIOMASS - plants used as fuel or fuel ingredients.

SOLAR - heat from the sun.

WIND - using the wind's energy to do work.

FOSSIL FUELS - the natural fuels created by pressure or decayed plant and animal remains over millions of years. Coal, oil and natural gas are the three fossil fuels.

PRODUCTION OF ELECTRICITY - methods explaining how electricity is produced using different sources, (i.e., coal, oil, water power, sun, wind).

COAL MINING - methods explaining how coal is extracted from the earth and the result on the environment. Strip and shaft mining are the two most common methods.

OIL - how it gets to you; trace the path of oil from the well to the consumer with steps in between for refining and production of a product.

KITCHEN CONSERVATION - conservation practices in the kitchen to save energy, using appliances wisely.

WATER CONSERVATION - ways you can save water by using it wisely.

ENERGY AND ECONOMICS- the cost of energy and the effect of the prices on everyday life.

HISTORY OF ENERGY - trace the use of energy from caveman to the steam engine to the present.

ELECTRICITY FROM GARBAGE (BIOCONVERSION) - using trash as a heat source to turn a turbine. This method can also make use of refuse-derived fuel, which is made by pulverizing garbage and then using pulverized materials as a fuel which can be mixed with other materials.

NUCLEAR ENERGY - using the heat from the nucleus

of a uranium atom. There are two basic kinds of nuclear energy: fission and fusion.
TIDAL POWER - using energy from the tides to produce electricity.
OIL REFINERY - the place where crude oil is broken down into different forms (gasoline, heating fuels, jet fuels, lubricating oils, and tars).
HYDROELECTRICITY - using the energy of water to produce electricity.
POLLUTION - the effect on the environment caused by smoke, automobiles, factories, and other man-made machines.
ACID RAIN - the rain falling on certain parts of the U.S. which has high acid content.
CAREERS IN ENERGY - careers such as meter reader, maintenance, clerical and administrative positions.
NATURAL GAS EXTRACTION - how wells are located and drilled to capture this fossil fuel.
COAL LIQUEFACTION AND GASIFICATION - two new methods for utilizing coal in an easily transportable and clean burning form.
TRANSPORTATION AND ENERGY - use of automobiles, trains, and mass transit systems. This is an excellent area in which to discuss car pooling and auto maintenance.
DRILLING FOR OIL - discuss the methods of surveying and locating oil and then the building of oil rigs to extract the oil.
PETRO CHEMICALS - many things are made from crude oil and gasoline. Aspirin and plastics are just a few.
RECYCLING - discuss how glass, aluminum and other metals, newspapers, and other materials can be used again to avoid depleting our natural resources.
OIL SHALE - taking the oil out of shale (a rock) to become more independent from foreign oil.
COGENERATION - using an energy device for more than one purpose. For example, a refrigerator cools but the heat it produces could be used for something else.
HOME CONSERVATION - explaining practices that can be done around the home to prevent escape of heat or excessive use of electricity.
GASOHOL - emphasizing that developing this fuel source uses Nebraska agriculture products.

Handout #2 : ENERGY EXPO GLOSSARY

GLOSSARY OF ENERGY TERMS

BIOCONVERSION - process using decaying organic plant matter or livestock wastes manure for conversion to methane gas.
BIOMASS - This idea envisions growing trees for use as fuel in electric power plants. A 400-square mile forest would fuel a small electric power plant.
MUNICIPAL WASTE - uses recycled trash as fuel in electric power plants.
COAL GASIFICATION - Coal can be turned into a gas through a chemical process. The process is very costly and yet economically feasible.
GEOTHERMAL - The heat energy trapped inside the earth's crust such as volcanoes and geysers. Natural steam is the most useable form of this energy and can be used to generate electricity. Accessible geothermal pockets are located mostly in the southern and western United States.
OCEAN THERMAL - Uses the temperature difference in surface and sub-surface ocean water to "boil" liquid freon, turning it into an high pressure vapor which can be used to spin an electric generator.
TIDAL - A large dam is built across a coastal inlet. As the tide rises, water is allowed to pass through the dam. When the tide goes out, the force of the trapped water is used to spin electric generators. Only two sites in North American have tides big enough to make this process work.
HYDRO POWER - Uses the force of falling water to spin electric generators. While this is an inexpensive way to produce electricity, most of the suitable hydro sites in the United States have already been developed.
NUCLEAR POWER - Over 40 percent of the electricity you use is probably nuclear energy. The first nuclear power plant began commercial operation in 1957. Today, over 100 nuclear plants are operating in the U.S.
FUSION - A nuclear process, still in early stages of development, that creates heat energy by fusing atoms together (not to be confused with nuclear fission - the splitting of atoms). Elements found in sea water could be used as fuel, creating a practically limitless fuel supply.
BREEDER REACTOR - An experimental reactor that makes additional nuclear fuel as it generates electric power. A breeder reactor can get 70 times more energy out of nuclear fuel than conventional reactors.
PETROLEUM - Petroleum fuels account for over 45 percent of the United State's energy usage. Our dependence on foreign petroleum is increasing. About half of our supply must be imported because U.S. reserves are not sufficient to keep up with the enormous demand.
NATURAL GAS - A fossil fuel, natural gas provides about 28 percent of our nation's energy needs. Like petroleum, natural gas reserves are dwindling.
SOLAR HEATING - using the sun's heat to warm

buildings or heat water. Technology is making solar heating systems more economical.

SOLAR PHOTOVOLTAIC - Converts solar radiation into electricity through special cells; used for small-scale generation of electricity but still years away from large-scale generation.

SOLAR THERMAL - Uses the sun's heat to boil water to turn a turbine to produce electricity.

WIND - Wind-driven electric generators are feasible for home use but unlikely for large scale generation. To equal the output of one conventional power plant requires 2,500 giant windmills with blades 200 feet in diameter rising 75 stories into the air.

STORAGE TECHNOLOGY - Perfecting ways to store large amounts of electricity. This is necessary to make other technologies such as solar thermal, and wind power economically feasible on a large scale.

Handout #3: TOPIC SIGN UP SHEET

Energy EXPO

Sign up Sheet

Group 1

Topic:

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Group 2

Topic:

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Group 3

Topic:

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Group 4

Topic:

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Group 5

Topic:

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Group 6

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Group 7

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Group 8

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Group 9

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Group 10

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Group 29

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Handout #4: LETTER TO PARENTS

Letter to Parents about Energy Expo__________, 19___

Dear Parents:

During the next few months your child will be studying the topics of energy conservation, fossil fuels and alternative energies. This study will be highlighted by an Energy Expo, which will be held on____________.

Your child will be researching__________________.
She/he will be working with a group to prepare a display for the Energy Expo.

Listed below are ___________'s required assignments and due dates. Please lend any assistance that you can and notify me immediately if you run into any problems locating information.

Thank you for your cooperation. Please sign this letter at the bottom to acknowledge its receipt. Any comments you have would be appreciated.

ASSIGNMENTS

1. OUTLINE - a brief outline listing major parts of the research (report), the individual project (a model or experiment), the group display (drawings and pictures), and the speech (group display description).
   Due Date:____________
2. WRITTEN REPORT - Each student is responsible for writing a report. We will be writing away for information, but the local library will also be helpful. Magazines contain up-to-date information about many of the topics that books may not have. The written report will consist of a cover, title page, table of contents, text, drawings/pictures, graphs/charts, maps (if possible), footnotes and bibliography.
   Due Date:______________
3. INDIVIDUAL PROJECT - Each student is also responsible for a project to accompany his/her written report. The project might be a large drawing to explain the topic, a model, a diagram or some type of experiment. Students can be very creative and artistic with this part of the project.
   Due Date:______________
4. GROUP DISPLAY - All students working on the same topic will contribute to the group display. Contributions might include charts, maps, pictures, items for home, or other information about the topic. Individual projects also become part of the group display but should not be the only contribution of a child. It will be necessary to begin the group display at least 6-7 days before the Expo.
   Due Date:__________
5. SPEECHES BY THE EXPERTS - Each student will try to become an expert on the topic she\he has researched. After the reports, individual project, and display area have been completed, each student should prepare a short speech or outline to explain the items in the group display. Each student should be able to explain all items in the area and be prepared to answer visitor questions.
   Due Date:_____________

I have seen the due dates and descriptions of__________________'s energy assignments. I will try to help as much as possible and see that assignments are completed on time.

Signature of Parent______________Date__________
Comments:

Handout #5: EVALUATION OF ENERGY EXPO

Date Began: ____________________

Expo Date: ____________________

Number of Students: ____________________

Number of Group Displays: ____________________

Teachers Who Participated: ____________________

Points To Ponder For Next Year: ____________________

ACTIVITY #9 ENERGY AND ECONOMICS IN AGRICULTURE

GRADE LEVEL

Upper Elementary, Middle Grades

TIME REQUIRED

5 - 7 Class Periods (50 Minutes)

RATIONALE

Energy is used extensively in agriculture, and energy costs contribute greatly to already high operation costs of the farmer. Agriculture consumes 3% of the total U.S. energy budget. Cost-efficient supplies of energy for agriculture are of great concern for producers of food. There is a growing cost of energy and energy-related farm inputs such as fertilizers, pesticides, herbicides, and operational fuel costs, that have already impacted greatly on agricultural production costs. The farmers' costs of production continue to rise at a prohibitive rate, yet the prices farmers receive for their goods have actually dropped below prices farmers received for goods fifty years ago. Continued increase of farm energy costs as we experienced in the 1970's could severely affect the American family farmer's ability to stay in business.

Farmers are keenly aware of the need to monitor their use of energy in farming. With other high farming costs and the high cost of energy, the motivation to use energy more wisely becomes of significant importance. The problem is losing the family farms due to rising production costs and falling commodity prices.

Energy management can help to hold down rising production costs. A farmer can increase profitability by achieving the maximum output for the least energy input. As one presently or potentially involved in agriculture, understanding the alternatives of energy efficiency can help save money, energy, and stretch fuel supplies.

OBJECTIVES

1) The student will view various techniques used to save energy on the farm.
2) The student will determine the trade-offs in using various types of energy in farming.
3) The student will demonstrate decision-making skills concerning efficient use of energy and its impact on productivity.
4) The student will determine the opportunity costs involved in the use of energy in farming.
5) The student will demonstrate various techniques for use in conserving energy on the farm and economic impact on the farmer.
6) The students will be able to read and interpret graphs contained in agricultural informational materials.
7) The student will demonstrate that energy management in agriculture could decrease energy costs and costs of farming and farm production could be held steady or decrease.

CONCEPTS

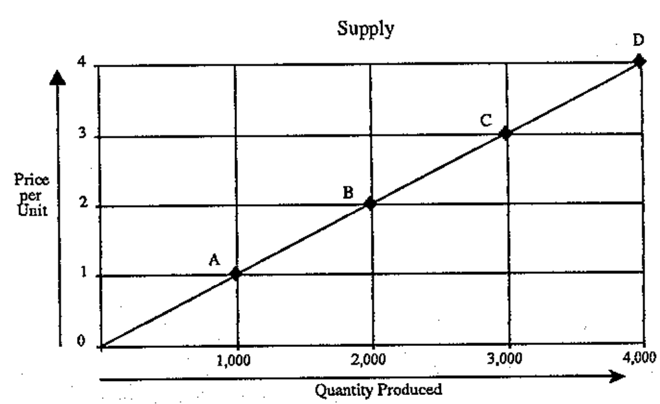
Conservation, reduced fuel and electricity usage, opportunity costs, trade-off prices, scarcity, parity, supply and demand and complications.

STRATEGIES

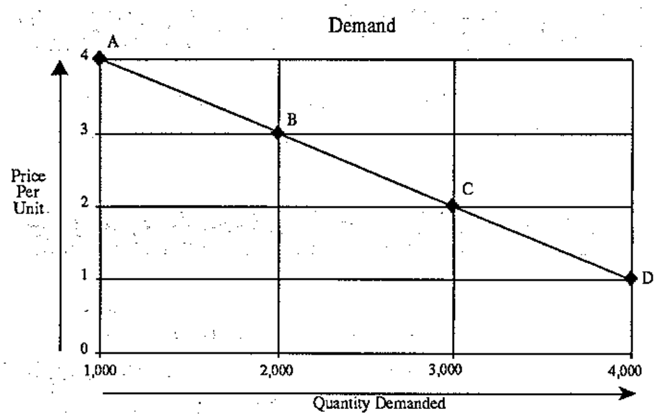
Lecture, research, demonstration, films, guest speakers, a visit to a local farm in which the farmer shows what equipment it takes (and the costs of such), and how much of the crop is necessary to meet expenses, then an estimation of how much crop it took to meet comparatively the same operating expenses fifty years ago.

BACKGROUND LESSON

1. In a market economy, supply and demand regulate the production and cost of goods. Supply is the amount of goods available for purchase to consumers. Two factors usually determine the supply: (1) cost of production and (2) the selling price. Generally, the higher the price, the larger the quantity that producers will be willing and able to supply. This is called the "law of supply."



2. If cost of production rises, the supply usually decreases (curve shifts left) because producers won't find it profitable to produce the same amounts at the original prices. They will require a higher price to produce at each original quantity.
3. Demand is the willingness and ability of consumers to spend money for goods and/or services. For most things in a given time period, the higher the price, the smaller the quantity that will be demanded. (Or the lower the price, the greater the quantity that will be demanded.) This inverse relationship between prices and quantities demanded is called "the law of demand." Notice that the graph of this relationship is a downward sloping demand curve.



4. Since a higher price is impossible in American agriculture, farmers have become increasingly efficient to keep production costs as low as possible. As prices for agricultural commodities decrease, farmers produce more in order to maintain the income that must be maintained to remain solvent. This is the problem of agriculture today, as the circle of events perpetuates itself, and the market economy theory becomes less valid.

QUESTIONS

1. How has government intervention affected agriculture's market economy?
2. What will happen to family farms if the government withdraws agricultural subsidies?
3. If you were the President of the United States, what could you do to decrease government spending, and yet save the family farms?

ENERGY AND PRODUCTION AGRICULTURE[1]

The agriculture producer is in the energy conversion business. Producers grow plants to convert sunlight into an energy source useful to human beings as a foodstuff, either directly as a food or indirectly as an input into livestock production.

Other inputs, including fossil fuels, are used to augment this energy conversion process. Production agriculture in 1977 used an equivalent of 274 million barrels of oil. Approximately 2/3 of this was used on the farm in the form of gasoline, diesel, gas, natural gas and electricity. The remainder was consumed in the production of fertilizers, herbicides, and pesticides.

U.S. farms are currently using about 5 million tractors, 3 million trucks and 5 million combines. More than 35 million acres are irrigated using pump systems. Over 20 million tons of fertilizer and 400,000 tons of pesticides are used annually by the nation's farmers. All of these require energy in some form — either as a fuel for operation or as a primary ingredient for manufacture. As a result, energy has become a basic raw material in agricultural production.

So far, energy use in agriculture has been a good investment. Food exports go a long way in balancing the international debts of the U.S. For example, in 1976 the $23 billion the U.S. gained in foreign exchange from agricultural exports paid for 68 percent of the total energy imports of $34 billion. One may say that investments of only 3 percent of the U.S. energy budget in agriculture made possible the purchase of more than 2/3 of the energy imports used in all aspects of the economy.

As energy use in agriculture increases, several problems become apparent from a public policy standpoint. To double world food production by the year 2000, would require a three-fold increase in energy use. At current rates, the U.S. population requires 1.4 acres per person to supply food. As our demand for food increases and our farmable land shrinks, the agricultural industry must become more energy-intensive.

Higher intensity farming means a greater demand on the fossil fuel supply. In order to step up production, the farmer needs more fuel, more fertilizer, more water, and other nutrients to make weaker land more suitable for farming. Basically, we need more oil if we want more bread.

Improved energy efficiencies can and should be achieved in the U.S. food system. Admittedly, conservation efforts

1 Energy and Production Agriculture. Agriculture Energy Conservation in South Dakota.

at saving energy on farms and ranches alone would have only a limited effect in alleviating a national crisis. However, because agriculture is based on biological processes, it is a unique energy user.

In the case of an energy shortage, the food production system cannot be shut down like a factory. Energy must be available in the proper form at the time needed, or the production process may be delayed and entire crops lost. The adverse effects upon our food production and delivery system would be widespread.

THE AGRICULTURAL SECTOR

In 1987, Nebraska had 56,000 farms, down from 66,000 farms a decade earlier. The total farm acreage in 1987 was 47,200,000 acres, or about 96 percent of the total area of the state. Of that 47,200,000 acres of farm land, 16,477,000 was planted to crops with the remainder in unplanted cropland, pasture, rangeland and woodland. Four major agricultural uses for energy are: field operations (primarily planting, tilling, and harvesting), irrigation, grain drying, and livestock operations.

The first three uses are dependent upon acreage and yields which in turn are affected by economical and weather conditions. For 1983 the acreage set-aside and diversion programs (including the Payment-In-Kind Program or PIK) had a major impact on corn, sorghum, and wheat acreages. The following table presents 1981, 1982 and 1983 planted acreages for major Nebraska crops. Notice how the PIK program affected the number of acres planted to crops.

Planted Area by Crop Type
('000 acres)

Crop	1981	1982	1983
Corn	7,400	7,400	5,300
Oats	550	520	670
Barley	30	28	75
Sorghum (Milo)	2,300	1,860	1,200
Soybeans	2,150	2,350	2,100
Dry Edible Beans	240	225	135
Sugar Beets	80	52	68
All Hay	3,650	3,800	3,650
Wheat	3,050	3,100	2,800
Rye	75	75	105
Total	19,525	19,410	16,103

Source: Nebraska Agri-Facts for 1981, 1982, and 1983

Energy for Field Operations
(Planting, Tilling, Harvesting)

Fuel	Energy Used* 1981	1982	1983 (est.)
Diesel - mill. gallons	60 (8.3)	58 (8.0)	49 (6.8)
Gasoline - mill. gallons	18 (2.2)	20 (2.5)	15 (1.9)
Total - (trillion Btu)	(10.5)	(10.5)	(8.7)

*Trillion BTU equivalent given in parentheses.

Although reports on the government programs indicate that feed grain (corn and sorghum) acreage will be down about 40% and wheat about 33%, energy requirements will not fall as much. First, this only accounts for about 20-22% of total acreage and second, a cover crop will be planted on much of the set-aside acreage.

Energy for Irrigation

In 1982, about 7.5 million acres were irrigated in Nebraska. Some 71,000 registered irrigation wells served approximately 90% of this need. The remaining 10% was irrigated from rivers, streams, or reservoirs. The following table shows 1981-1982 energy usage by fuel type:

Energy for Irrigation

Fuel	Energy Used* 1981	1982
Diesel-million gallons	81 (11.2)	72 (10.0)
Electric - million kwh	800 (2.7)	800 (2.7)
Gasoline - million gallons	2 (0.2)	2 (0.2)
Propane - million gallons	26 (2.5)	39 (3.7)
Natural Gas - mcf**	4284 (4.3)	4290 (4.3)
Total - (trillion Btu)	(20.9)	(20.9)

*Trillion BTU equivalent given in parentheses.** 1 mcf = 1000 cubic feet of natural gas.

Assuming similar weather conditions for 1983 as for 1981 and 1982, and an approximate proportionate decrease in irrigation requirements to total acreage, **a reduction of 20-25 percent in energy requirements is projected by the Nebraska Energy Office**. If the weather is hotter and dryer than the past two years it is obvious that less of a decrease would occur.

Corn and grain sorghum are the two grains requiring the most energy for drying. Small grain, soybeans, and others require rather insignificant amounts.

The following table shows 1981-1982 energy requirements for drying by fuel type:

Energy for Grain Drying

Fuel	Energy Used* 1981	1982
Natural Gas - mcf	6283 (6.2)	6070 (6.0)
Electricity - million Kwh	332 (1.1)	318 (1.1)
Propane - million gallons	36 (3.4)	45 (4.3)
Total - (trillion Btu)	(10.7)	(11.4)

*Trillion BTU equivalent given in parentheses.

Assuming yields similar to those attained in 1981 and 1982 The **Nebraska Energy Office expects energy requirements for grain drying to decrease approximately 30 percent.** This is more than the proportionate decrease in total acreage but takes into account that corn and sorghum are the two primary grains involved in drying.

Again, fuel needs depend upon the weather to the extent that if crops dry well in the field, fuel needs are less than otherwise.

Other Agricultural Energy Use
Other agricultural uses for energy include livestock operations, lighting in farm buildings, and other farm machines. This usage for 1981 and 1982 follows:

Other Agricultural Energy Use

Fuel	Energy Used* 1981	1982
Electricity - million Kwh	155 (0.5)	146 (0.5)
Propane - million gallons	2 (0.2)	3 (0.3)
Diesel - million gallons	25 (3.5)	25 (3.5)
Gasoline - million gallons	12 (1.5)	15 (1.9)
Total - (trillion Btu)	(5.7)	(6.2)

*Trillion BTU equivalent given in parentheses.

The Nebraska Energy Office projects that requirements for 1983 are expected to remain near the levels of 1981 and 1982.

Thus, estimated total energy requirements by agriculture for 1983 are:

Agriculture

Estimated Energy Needs in 1983*

Fuel	Amount
Diesel - million gallons	128-133 (17.7 - 18.5)
Gasoline - million gallons	28-30 (3.5 - 3.7)
Electricity - million Kwh	960-1030 (3.2 - 3.5)
Propane - million gallons	53-57 (5.0 - 5.4)
Natural Gas - mcf	7250-7800 (7.2 - 7.8)
Total - (trillion Btu)	(36.6 - 38.9)

*Trillion BTU equivalent given in parentheses. This compares with usage of 48 trillion BTU in 1981 and 49 trillion BTU in 1982.

The following are energy management activities which students can do that will demonstrate the economics of energy in farm production.

Exercise IV: DECISION MAKING

Correct decision making in production agriculture today is becoming the deciding factor in a farmer's ability to stay in business. Not only must today's farmer fight the weather, pests, weeds, and diseases, he must also be a completely informed businessman that can make informed decisions critical to him and his industry.

The Economic Decision-Making model is a perfect vehicle for training young agriculturists to make accurate and critical decision about energy use in all phases of business.

Just a decade ago, energy costs were rising at a rate that left many farmers unable to realize a profit, even if they survived all the natural problems associated with agriculture.

At this time decisions had to be made about farming practices that wasted of energy. From these problems came the "new ideas" of agronomy such as minimum tillage, increased conservation, and crop rotation. Some of the major energy "wasters" were identified as grain drying, irrigation, and pest control practices. The cost of these practices outweighed their benefits in times of high energy cost.

DIRECTIONS

Use HANDOUTS #1, #2 & #3.

1. Construct a decision-making grid for each of the following subjects: main tillage, grain drying, irrigation, pest control.
2. Use the data to determine to what degree you would use these practices in a farm operation today.
3. Determine what adjustments would be necessary to adapt to an energy shortage like the one in the seventies.
4. How can a beginning farmer prepare himself for this possible turn of events?

Handout #1: YOU CHOOSE: SCARCITY AND PERSONAL DECISION MAKING

COMMENTARY: FOR YOUR INFORMATION

Time and Money

What are your most pressing problems? They probably involve managing time or money. Dozens of books are published to help individuals and families manage time and money. Teachers must cope with stress related to lack of time, money, energy, and other resources. Many students are familiar with problems related to time and money management.

Time management studies are conducted in all major industries and consultants are hired daily to help people with financial planning. People who want to have greater control over their lives find they must manage carefully their time and money resources to do so.

Making Choices

Both individuals and societies face scarcity. Scarcity exists whenever people want or need more resources (money, time, or energy) than are available. Scarcity requires making decisions and choices. Hastily-made and not-carefully-thought-out decisions often have unsatisfactory results and unanticipated consequences. Careful decision making involving the thoughtful evaluation of various alternatives, is a valuable skill that can help individuals make the best use of their scarce resources.

	Goals for Criteria			
Alternative	Goal or Criterion 1	Goal or Criterion 2	Goal or Criterion 3	Goal or Criterion 4
Alternative 1				
Alternative 2				
Alternative 3				
Alternative 4				

Purpose of Budgeting

The main purpose of budgeting is to maintain control over money, time, or energy. Looking at wants and resources and planning ahead reduce the chances of things "just happening."

SCARCITY is the condition that exists whenever wants are greater than available resources. For individuals, scarcity results from limitations on the supply of personal resources like time, energy, space, or money. For society, scarcity results from limited productive resources such as land, labor, and capital goods, which have alternative uses.

CRITERIA are the standards by which alternatives are judged and the basis for choosing one alternative over another. They may be in the form of statements or questions that can be asked about each alternative.

CHOICES refer to those decisions that must be made when scarcity exists and limited resources can be used in alternative ways.

OPPORTUNITY COST is the loss of the next best alternative when scarce resources are used for one thing rather than another.

BUDGETS are plans that people make to help determine how they will spend their time or money.

SAMPLE DECISION-MAKING PROCESS[2]

Frank wants to give his friend Bob a birthday present, but has only $3.00 left in his budget for gifts and miscellaneous items. Bob's birthday is in four days.

Frank knows that Bob wants a new rock album that costs $23.95 and that Bob liked very much a stained-glass window hanging Frank made last year. The hanging cost $10.00 for supplies and took six hours to make. Frank could make another if he had enough money for supplies.

Frank's father has agreed to pay him $3.00 an hour for inventory work in his store after school. But Frank also has homework and intramural sports. What should Frank do?

STEP ONE: DEFINE THE PROBLEM. Frank has a scarcity of time and money. He wants to buy or make a gift for Bob but has only four days.

STEP TWO: IDENTIFY ALTERNATIVES FOR DEALING WITH THE PROBLEM. (The grid shows four alternatives that Frank has. Students may be able to think of others.)

2 Adapted from the Master Curriculum Guide in Economics: A Framework for Teaching the Basic Concepts, 2nd ed., Joint Council on Economic Education, 432 Park Avenue South, New York, NY 10016.

STEP THREE: SPECIFY CRITERIA TO BE EMPLOYED IN EVALUATING THE ALTERNATIVES. (The grid shows four possible criteria. There are others students might think of.).

STEP FOUR: EVALUATE THE ALTERNATIVES. Place a plus or minus in the boxes of the grid to show whether each criterion is being met by that alternative. In some cases more than one plus or minus can be used to show the strength of the alternative or the preference of one criterion over another.

STEP FIVE: MAKE A DECISION. Select the alternative that best meets your criteria. (Students may see which alternative has the most pluses or the least minuses. They may determine that some criteria are more important than others. Encourage students to explain their decisions. Notice that the model does not provide a single "right" decision; rather it helps the individual see clearly the implications of his or her own decision.).

Handout #2: A DECISION-MAKING MODEL

1. DEFINE THE PROBLEM

2. LIST ALTERNATIVE METHODS OF DEALING WITH THE PROBLEM

3. SPECIFY CRITERIA TO BE USED IN EVALUATING THE ALTERNATIVES

4. EVALUATE THE ALTERNATIVES

5. MAKE A DECISION

DECISION-MAKING GRID

Handout #3:[3] MINIMUM TILLAGE

Minimum tillage involves leaving crop residues on the soil surface and minimizing plowing, disking, or harrowing. Usually only the soil directly around the plant is prepared and maintained during planting and cultivating seasons.

Benefits due to minimum tillage are reduced soil erosion, increased soil moisture, and better double cropping opportunities. However, pesticides (which use energy) will increase under this practice. Costs of minimum tillage could include buying a grain drill to plant the crop, using manual labor to control noxious weeds, and purifying grain produced so it won't be full of weed seed.

1. Have students compare fuel consumption of cropping methods.
2. Have students compare crop yield under each method.

GRAIN DRYING

1. Have students monitor the time, energy used, and cost of drying grain mechanically versus later harvest.
2. Have a farmer show students how to test grain moisture and explain how much money is lost if moisture content is not acceptable.
3. Students should include in their reports the costs and dollar savings of each method. Also evaluated should be crop loss under later harvest versus mechanical drying methods, keeping stored grain from rotting and ruining the whole bin, and maintaining a moisture rate in the stored crop.

IRRIGATION

Energy efficiency is very important as the use of irrigation systems grows. Most water for irrigation must be pumped from wells, streams, or reservoirs in order to irrigate crops. This requires much power, and even more may be necessary for the distribution of water in irrigation systems. Energy use in irrigation can significantly increase the costs of production for the farmer.

Good water management can be very important in reducing energy and fertilizer costs. One must know when and how much to apply.

1. Have students do an activity on irrigation scheduling using moisture blocks. Moisture blocks, properly placed, will give the farmer information needed as to when irrigation is necessary. Students compare the use of irrigation scheduling versus no scheduling and the use of moisture blocks versus no use of moisture blocks. Students will evaluate the cost, energy used, and energy saved under each method.
2. Have students prepare a demonstration of irrigation scheduling and the use of moisture blocks in irrigation.
3. Have students prepare and disseminate information on additional methods of saving energy and dollars in irrigation systems, such as incorporating production chemicals for application in the water system.

3 The Agricultural Sector. Energy and Nebraska, 1983.

PEST CONTROL

Pesticides and herbicides are chemicals used by farmers to protect their crops from insects, weeds, and diseases. Crop yields could be much lower without their use. However, these materials require the use of fossil fuels in their manufacture, transportation, and application. Prices for pesticides and herbicides continue to increase, cutting into farm income.

1. Have students investigate and demonstrate ways the farmer can reduce pesticide use.
2. Have students determine crop damage by insects and its economic impact upon the farmer's income.
3. Students determine different pest control techniques based on economic threshold levels. The evaluation of which is more costly: damage caused by pest or cost of applying the pesticide. Costs involved in application of pesticides include those for machinery, labor, fuel for equipment and for the chemical itself.
4. Have students apply crop rotation and compare the results of pest management of each crop. Students will determine that insects attracted to one crop may not be attracted to another. Determine the cost and energy savings of this method.

ACTIVITY #10 COMMUNITY ENERGY INVESTMENT BOND

GRADE LEVEL

Upper Elementary, Middle Grades

TIME REQUIRED

5 - 8 Class Periods (50 Minutes)

RATIONALE

Energy consumption, particularly electrical consumption, often occurs without the consumer being aware of the amount being used. Many people have no idea of how much energy they use in their homes, where it comes from, where it goes, or how to make the most of it. Students can become involved in energy management in their community by pledging to reduce energy consumption through various energy-efficient techniques. The dollars saved through energy management can be used toward the purchase of goods and services other than energy in the community. This activity presents information to students about how to measure electrical consumption, increase their awareness of the inverse relationship between price and quantity demanded, and involves them in energy management activities within their homes and communities.

OBJECTIVES

1) Students will study the economic law of demand using electricity as the example.
2) Students will read electricity meters to measure consumption over a specific period of time.
3) Students will compare electricity usage over different time periods.
4) Students will identify price and other factors that may influence the demand for electricity.
5) Students will determine ways in which to reduce their energy consumption.
6) Students can demonstrate a willingness to cut back on home energy usage by signing an energy investment bond.
7) Students will observe that limiting energy usage can reduce their energy bills. Dollars saved are available for additional economic activities in the community.

CONCEPTS

Conservation, energy management, demand, price and quantity, energy audit and consumption of goods and services.

STRATEGIES

Lecture, guest speakers, films, simulation models, discussion, application and field trip to utilities or appliance stores.

Exercise I:
A HOME SCAVENGER HUNT[1]

Give students copies of worksheets. Have students complete the worksheets. Ask students to calculate how much energy they used this morning before they came to school. How much could they have saved this morning?

Worksheet for Exercise I
ELECTRICAL USE

DIRECTIONS

Go on a scavenger hunt for things that use electricity around your home. On the chart list all the items you find. You will probably need to continue the chart on another piece of paper. Each item will have a label that tells you how much electricity it uses. The label can usually be found on the bottom or back of the appliance. Remember, the amount of electricity used is measured in watts. Record the watts used on the chart. Be sure to ask for permission before moving appliances to read the watts label. If you cannot find the watts label, or if it is difficult to get to because it involves moving a heavy appliance, visit a local appliance store.

Name of Item	Watts

1. How many items were you able to find? Who found the most?
2. Which items use the most electricity?
3. Were you surprised by which appliances used the most electricity?
4. Assume that each of the 74 million families in the United States operated the 5 appliances you used in this activity for one hour. How much oil would be burned? How much coal?

Worksheet for Exercise I
CONVERSION[2]

Use the Electrical Appliance Energy Table to see how much fuel is required to produce different wattages per hour. Notice that it takes one ounce of oil or one-and-one third ounces of coal to make one 100-watt light bulb work for one hour. Select five appliances and calculate how much oil or coal must be burned to operate each for one hour.

Electrical Appliance Energy Table

Appliance Wattage Rating	Ounces of Oil Burned per Hour	Ounces of Coal Burned per Hour
10	1/10	13/100
25	1/4	33/100 or 1/3
40	2/3	1/2
60	3/5	4/5
100	1	1 1/3
150	1 1/2	2
200	2	2 2/3
300	3	4
500	5	6 2/3
750	7 1/2	10
1000	10	13 1/3
1500	15	20
2000	20	26 2/3
5000	50	66 2/3

Worksheet for Exercise I
NECESSITY OR LUXURY[3]

DIRECTIONS

Many electrical appliances are available today. Some of them are necessities, while others are luxuries. Look at the list below and mark whether each item is a luxury or necessity.

	Necessity	Luxury
1. Hair dryer		
2. Furnace		
3. Dishwasher		
4. Clothes washer		
5. Clothes dryer		
6. Ceiling light		
7. Calculator		
8. Toothbrush		
9. Air conditioner		

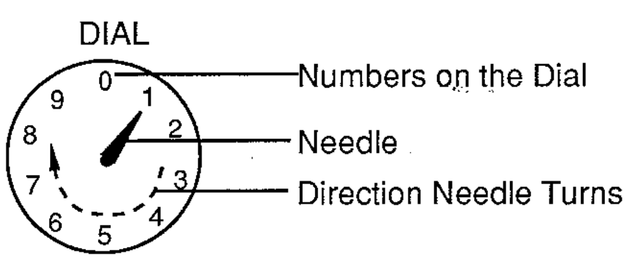
1 "Scavenger Hunt". Teaching Economics - Content and Strategies. Ronald A.Banaszah and Dennis C. Brennen. Addison Wesley Publishing Company, Inc., 1983. 2 Home Energy Check, Arkansas Energy Office.3 Home Energy Savings Tips, Lincoln Electric System, Lincoln, Nebraska, 1983.

	Necessity	Luxury
10. Stereo		
11. Refrigerator		
12. Stove		
13. Heater for swimming pool		
14. Humidifier		
15. Range Hood		

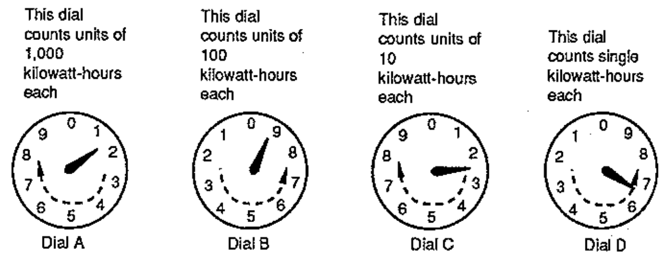
Exercise II
METER READING [4]

1. Each student will learn to read electric meters and then record daily/weekly/or monthly readings. Patterns should develop through these readings that will indicate an energy use and consumption pattern for each household. Factors, such as weather, should be noted in the record keeping.
2. Students, during the same time period, will brainstorm for ways in which to reduce their household and community usage of energy.
3. A plan will be developed by each student detailing ways to reduce his or her energy usage.
4. Students will determine dollars spent on current energy usage versus dollars spent on plans for reduced energy usage.
5. Students will suggest ways in which this dollar savings can be added to the local economy.

The amount of electricity you use is measured by a METER attached to your house or apartment. Some electricity meters have dials on which one or more needles will point to the number of kilowatt-hours of electricity that you have used since the meter was installed. One of the dials on the meter will look like this:



STUDY THE ILLUSTRATION BELOW.



Dial A. The needle turns in a clockwise direction.
Dial B. The needle turns in a counterclockwise direction.
Dial C. The needle turns in a clockwise direction.
Dial D. The needle turns in a counterclockwise direction.

As the needle turns in a clockwise or counterclockwise direction, it counts one unit of electricity used. The number of units counted is THE LAST NUMBER PASSED BY THE NEEDLE.

The diagram in the preceding column of the single dial shows that one unit of electricity has been counted.

STUDY the second illustration carefully to notice that several dials are needed to count the total number of units of electricity used in a home. The reason for the four dials is that each dial can count only ten units, so each dial as explained will count a unit of a different size.

Notice that the needle of DIAL A has just passed the number 1. Therefore, this needle has just counted one unit that measures

(a)_______________(1, 10, 1000) kilowatts-hours.
DIAL A measures
(b) _______________kilowatt- hours.

The needle on DIAL B has just counted the number 9. This needle has just counted 9 units, each measuring (c)__________ (9, 100, 900) kilowatt- hours. DIAL B reads (d)_________ (9, 100, 900) kilowatt-hours.

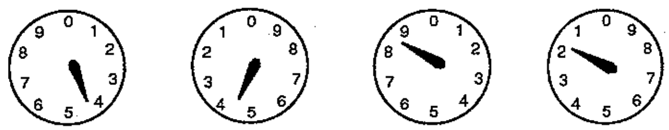
The needle on DIAL C has just counted the number 2. DIAL C reads (e)___________ (2, 10, 20) kilowatt-hours.

The needle on DIAL D has just counted the number 6. DIAL D reads (f)___________ (6, 60, 1) kilowatt-hours.

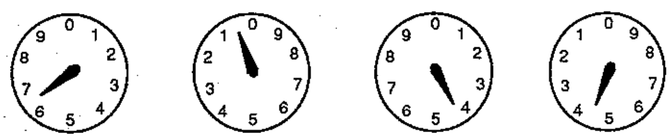
In order to get the total reading of the electricity meter shown above, we must add together the readings on DIALS A, B, C, AND D. In other words, we must add to get a total of (g)_______________ kilowatt-hours.

4 How To Calculate Your Energy Dollar, U. S. Department of Energy. Grant #DE-FGUN-80C562029.

Each month a person from the power company is sent to your home to read your electricity meter. His or her job is to determine how much electricity you used during the month. For example, suppose your meter looked like this in the month of April:

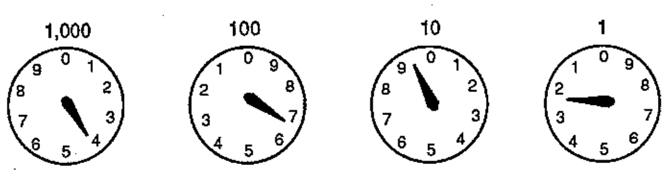


According to the meter, you have used to date (h)________kilowatt-hours of electricity. In May, the person from the power company makes another reading.



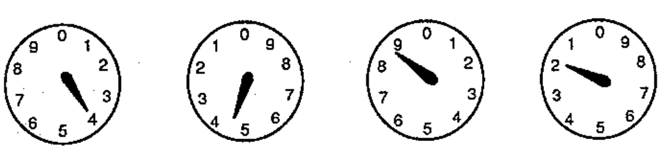
He finds that your electricity meter now reads (i)__________ kilowatt-hours. Since the April reading you have used (j)___________ kilowatt-hours. You find this by subtracting the April reading from the May reading. YOU SHOULD NOW BE ABLE TO FIND AND READ THE METER FOR ELECTRICITY IN YOUR OWN HOME.

Study the meter below. Fill in the blanks beneath each dial.



means (k)___ kilowatt-hours	means (l)___ kilowatt-hours	means (m)___ kilowatt-hours	means (n)___ kilowatt-hours

According to your calculations, this meter shows that a total of (o)_______ kilowatt-hours have been used. The meter shown below reads (p)________ kilowatt- hours.



HOW ELECTRIC BILLS ARE COMPUTED
SAMPLE ENERGY CHARGE

First 200 kwh at	$ .0430 per kwh
Next 1300 kwh at	.9260 per kwh
Over 1500 kwh at	.0215 per kwh
Total Kwh at (Fuel Clause)	.00215 per kwh

SAMPLE BILL COMPUTATION
Suppose that your total electricity consumption for the month amounted to 500 Kwh. The charge for this monthly consumption would be figured out in this way.

First 200 kwh at $.0430 .... $8.60
Next 300 kwh at $.0260 .... $7.80
Total of 500 kwh at $.00215 ... $1.08 (Fuel Clause)
Total. 17.48

COMPUTING ELECTRIC BILLS
Work all problems on this paper showing the calculations for each. Use the sample rate schedule to do these.

1. Mr. Collins read his meter at the beginning of May. It read 4335 kwh. When he subtracted the April reading of 3916, he found the number of kilowatt-hours he used in one month. What would his electric bill amount to in Green Bay?
   a. Subtract b. First 200 kwh c . Next 300 kwh d. Total? (add b & c)
2. Can you find an error in this bill?

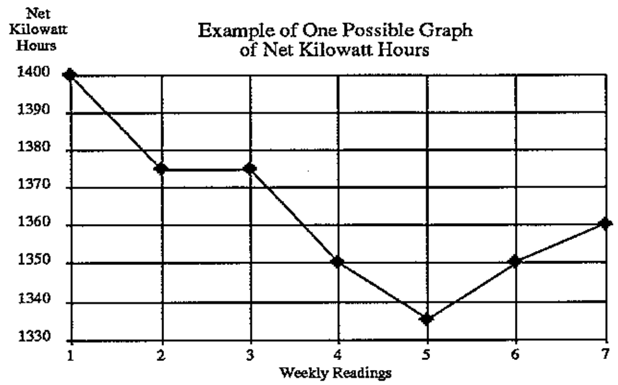
Mr. J. J. Jones 111 Energy Blvd.
Antsville, Indiana 60761

Previous reading	Present reading	No. kwh Used	Amount Due
3569	4129	560	$20.16

Recording daily/ weekly/ or monthly energy usage in home.

Daily Use of Electricity in my Home

	Date and Time	Weather or other factors	Electric Meter Reading (kwh)	Kilowatt-Hours Used Daily (#2- #7)	(kwh
1.					
2.					
3.					
4.					
5.					
6.					
7.					



Exercise II: METHODS OF REDUCING ENERGY CONSUMPTION[5]

Various methods of reducing electrical consumption at home or at school can be discussed in class. Discussions might focus on which electrical appliances consume the most electrical energy (furnaces, dishwashers, toasters, air conditioners, water heaters, etc.), and which appliances are used most often. Some specific methods for reducing consumption could be suggested: turning down the water heater thermostat from around 150 degrees Fahrenheit to 110 degrees; opening the door of the dishwasher during the dry cycle and letting the dishes air dry; using the air conditioner as little as possible; etc.

Additional methods could come from a brainstorming session of students; from guest speakers from the utilities; from research on energy conservation in the home; or a questionnaire to survey students and teachers on various means of conserving energy at home. (Student Information on WORKSHEETS #4 and #5).

ADDITIONAL INFORMATION FOR ACTIVITY

Using the information below, have students calculate how much money they spent on energy this month. Then take the money spent times twelve months a year and see what they could have bought for themselves with the money spent on energy costs within the last year.

INVESTMENT BOND

1. Each student will pledge to reduce their home energy consumption by filling out and signing the Investment Bond.
2. Students will report back to the class in designated time period on their actual energy and dollar savings.

Worksheet III HOME ENERGY CHECK

ATTIC

INSULATION - IS YOUR ATTIC PROPERLY INSULATED? Using the ruler, measure the depth of the insulation between your ceiling joints. The recommended R-value for Nebraska homes is R-38.

VENTILATION - IS YOUR ATTIC PROPERLY VENTILATED? Attic ventilation is important to reduce the build-up of moisture in the winter and to reduce heat gain in the summer. The general rule of thumb for attic ventilation is one square foot of vent for every 300 square feet of attic or one square foot for every 150 square feet of attic if your attic does not have the proper moisture barrier. Better yet, consider installing a power ventilator.

LIVING AREA

INFILTRATION - IS YOUR HOUSE PROPERLY SEALED TO STOP AIR LEAKS? Cracks around windows and doors allow heat to escape in the winter and to enter in the summer. To test, hold a lighted candle by the windows, door frames, and attic doors (in the presence of an adult). If the flame flickers, you need weather-stripping and caulking and perhaps even storm windows. Remember: an 1/8" crack around your door is equal to approximately a 6" diameter hole in your wall!

WALL INSULATION - ARE EXTERIOR WALLS PROPERLY INSULATED? Uninsulated walls can contribute greatly to your heating and cooling bills. To see if your walls are properly insulated, turn off the electricity in your home at the main circuit. (Do not do this without the supervision of an adult). Remove the cover plate from an electrical outlet on an exterior wall. By checking around the electrical box, it is possible to determine whether or not your walls are insulated. If insulation is present, additional insulation is not generally feasible or economical. For uninsulated walls, the recommended R-value is R-19.

FIREPLACE - IS YOUR FIREPLACE BEING USED EFFICIENTLY? While fireplaces contribute greatly to the aesthetics of a home, they can also lead to tremendous energy waste. Make sure the damper is closed when the fireplace is not in use. Also consider installing glass screens and outside ventilation to insure the most efficient use of your fireplace.

5 Community Energy Investment Bond, U. S. Department of Energy. Grant #DE-FGUN- 80C562029.

THERMOSTAT - IS YOUR THERMOSTAT SET FOR SAVINGS? Your thermostat should be set at approximately 68 degrees for winter heating (turn down five more degrees when sleeping). Air conditioning should not be set lower than 78 degrees in the summer. Remember: every degree you turn down your thermostat from 70 degrees reduces your heating bill by approximately 3%.

DRAPERIES - ARE YOU USING YOUR WINDOWS TO THEIR BEST ADVANTAGE? During winter, draperies and shades should be opened to allow sunlight in to help warm your home. At night, draperies would be closed in order to reduce heat loss. In the summer, draperies should be closed at all times in order to keep the sun's heat from entering your home.

UNUSED ROOMS - ARE YOU HEATING AND COOLING AREAS YOU DO NOT USE? In this way you are paying to condition areas which will not be occupied.

KITCHEN

SEALS - ARE ALL APPLIANCE SEALS IN GOOD CONDITION? To test, close a dollar bill in the doors of your freezer, refrigerator, and oven. If the dollar bill can be removed with little resistance, the appliance is leaking energy and costing you a good amount of money. Replace the seal.

APPLIANCES - ARE MAJOR APPLIANCES BEING USED EFFICIENTLY? Major appliances use major energy. Use washers and dryers only when you have a full load. Some dishwashers contain an energy-saving cycle that allows the dishes to air dry. Major appliances should be used only during the morning and late evening hours or on weekends, when energy requirements are not at their peak. By using electricity during "off-peak" hours, you're saving your own and the country's energy.

LIGHTS - ARE EMPTY ROOMS KEPT LIT? Lighting empty rooms wastes energy. Lights should be used only on an as-needed basis, never just for decorative effect. Consider installing fluorescent bulbs wherever possible. Fluorescent lights use less energy but give off the same amount of light as ordinary incandescent bulbs.

HEATING AND COOLING SYSTEMS

HEATING AND COOLING SYSTEMS - IS YOUR HEATING AND COOLING SYSTEM WORKING AT PEAK EFFICIENCY? Clean or replace furnace and air conditioning filters at least once a month. Dirty filters make equipment work harder and use more energy. Have your unit serviced at least once a year. A professional inspection can help your furnace operate more efficiently and help to avoid major repair.

DUCTS - IS ALL DUCTWORK PROPERLY INSULATED? Without proper insulation, heating and cooling ducts in unconditioned spaced can rob your home of energy before it ever reaches you. All ducts going through unconditioned areas should be insulated to at least R- 7.

THE OUTSIDE

WINDOWS - IS YOUR HOME EQUIPPED WITH STORM WINDOW/DOUBLE PANE GLASS TO REDUCE HEAT LOSS? Next to the attic, windows usually account for the greatest amount of energy waste. By installing storm windows or double pane glass, it is possible to cut the heat loss through the windows by as must as 50 percent. To reduce summer heat gain, windows should be shaded with overhand awnings or shade trees.

WEATHERSTRIP AND CAULKING — ARE THE CRACKS IN YOUR HOME ALLOWING YOUR HARD-EARNED MONEY TO LEAK OUT? Weatherstripping and caulking are extremely important in sealing up your home. All cracks around windows, doors, electrical outlets, and outside faucets should be sealed. Infiltration drafts and cold spots cause higher utility bills.

DOORS - IS YOUR HOUSE EQUIPPED WITH STORM DOORS? Storm doors have been found to be effective in reducing winter heat loss and summer heat gain. For that reason it is profitable for your to keep tight-fitting storm doors on your home year round.

Worksheet IV
HOW TO CHECK YOUR HOME ENERGY CONSUMPTION[6]

A simple calculation using the energy consumption recorded on your utility bills will show whether your home is energy efficient or wasting money.

Take a minute to get out all your electric bills and gas bills for the past 12 months, and list them in a column - add up the year's cost, and the year's consumption of kilowatts, or quantity of gas your family used.

 6 Home Energy Check, Arkansas Energy Office

To obtain a single figure showing total energy consumption, perform these calculations:

1. Multiply the year's kilowatts times 3,412 to obtain the British thermal units, or BTÜ's consumed.
2. Take the year's total consumption of natural gas, and multiply the thousands of cubic feet times 1,030,000 to get the gas BTU's consumed.
3. If your home uses propane, multiply the gallons of propane consumed times 96,600 to get the propane BTU's consumed.
4. Add together all the BTUconsumption figures.
5. Divide that sum by the number of square feet of housing that is heated and cooled.

That results in the number of BTU's per square foot consumed in a year's time.
Compare your energy consumption to this chart:
Under 50,000 BTU's wins you an A; you have an energy efficient home.

From 50,000 to 80,000 BTU's gives you a B; you are trying.

From 80,000 to 120,000 BTU's gives you a C; this is the average consumption among today's homes.

From 120,000 to 175,000 BTU's gives you a D; you can do better and should give your home an Energy Check.

From 175,000 BTU's on up you receive an F; you are throwing away money.

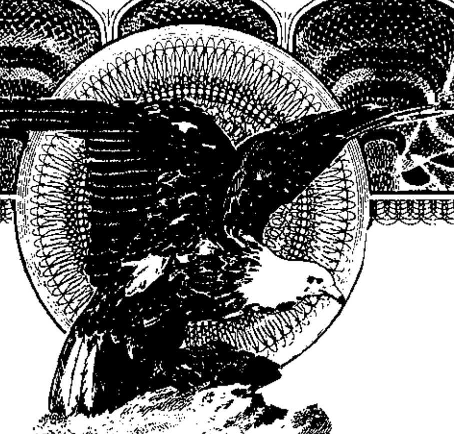
Worksheet V
INVESTMENT BOND

How to Calculate Your Energy Dollar Savings

Check the boxes below indicating the energy saving ACTIONS you are willing to take.

I WILL	VALUE
____Take fewer car trips, ride with others, walk or bike more often. (reduce 5%)	$41
____Check the tire pressure on my car each month.	$31
____Lower the temperature setting on my water heater.	$10
____Install water flow restrictor on showerhead/faucet.	$15
____Fix leaking faucets.	$15
____Keep unused rooms closed.	$25
____Keep closet doors closed.	$5
____Lower my thermostat by 5 degrees.	$20
____Install a flue damper in my chimney.	$23
____Turn off my furnace pilot light during the summer.	$10
____Replace the furnace pilot light with a more energy efficient one.	$31
____Weatherstrip doors and windows.	$13
____Caulk around doors, windows, pipes and cracks.	$10
____Insulate my walls.	$335
____Add more insulation (3-4") to my attic.	$40
____Others	$____
TOTAL	$____

NOW total the dollar value of the boxes you checked, Enter this number on the other side (first and second blanks) of this bond,
THEN since every community dollar saved that would have been spent on energy adds more economic activity to the local economy when spent HERE on local goods and services.
MULTIPLY TOTAL DOLLARS SAVED
$_____x 2 = _____ (New Total) to see how much your local economy can benefit NOW enter the new total in the third blank on the other side of this bond.



I promise to build ____________________economy.

Through energy management, I can reduce my energy consumption and save $_________. By using this $__________to purchase local goods and services rather than energy, I will be adding an extra boost of $________ to__________________ economy.

____

ACTIVITY #11 CAN YOU MAKE A DIFFERENCE?

GRADE LEVEL

Middle Grades, High School

TIME REQUIRED

4 - 6 Class Periods (50 Minutes)

RATIONALE

The more people you can convince, educate, or involve in energy issues, the more energy and energy dollars can be saved in the community. It is important to know how energy is used, what types of energy are used, how much energy is used, and how rates are determined. Students should be aware of issues facing their communities: how much energy is costing them and the impact they can have on those rates. Energy education is the foundation for helping people learn how to change their priorities and lifestyle patterns.

OBJECTIVES

1) Students will list fundamental energy resources and discuss their use and distribution.
2) Students will identify the role of government in the process of setting utility rates.
3) Students should be able to answer questions concerning: rate structure, rate regulation, and peak load management and its economic impact.
4) Students should be able to ask pertinent questions concerning energy issues. They will use this information in their roles as citizens in energy decision making.

CONCEPTS

Energy information, consumer awareness, peak load management, rate structure, price and demand, role of citizens and government intervention or regulation.

STRATEGIES

Lecture, research, guest speakers, films and field trips.

BACKGROUND LESSON AND EXERCISES

Scarcity is defined as peoples' wants exceeding the resources available. The economic system helps a society allocate scarce resources. In a market economy, allocative price rationing depends on determining the price of the resource. As the price increases, some buyers must limit their usage, or they are rationed out of the market. As the price decreases, more consumers will be willing and able to buy the resource. This is the definition of demand for a commodity like energy. Energy resources are subject to the economic concept of scarcity.

Exercise I: DEMAND [1]

1. Construct a demand curve from the following demand schedule for oil.

Price Per Barrel	Barrels demanded per week
$36	100
32	300
28	700
24	1,000
20	2,100
16	3,100
12	4,300
8	5,700
4	7,300
1	9,100

Fill in the blank with correct words from the list below.

2. Demand is a schedule which tells the__________ of something that people are willing and able to purchase at each specific___________ during a specific time period.
3. This curve illustrates the "Law of Demand" which states that there is a(n)__________ relationship between price and quantity demanded.
4. Changes in this demand curve could be caused by changes in________ , or _________.
5. An increase in income would probably increase demand. This means___________of the product or service would be purchased. The demand curve would shift to the_________of the original.
6. From the Law of Demand, we can conclude that higher prices generally cause us to demand___________of a product.

Words to use

quantity	price
direct	incomes
tastes	price of substitutes
inverse	less
right	more
left	

Answers to worksheet questions: (2) quantity, price (3) inverse (4) tastes, income, prices of substitutes (5) more, right (6) less

Worksheeet for Exercise I DEMAND

The interaction of forces which determine demand and supply lead to what economists call the market equilibrium price and quantity. It is at this equilibrium point that the quantity supplied equals the quantity demanded. That is, there is neither a shortage nor a surplus. Analysis of how the market reaches an equilibrium is necessary for understanding how a free market economic system should operate.

1. Using the supply schedule below, construct a supply curve using the price-quantity measures on your demand worksheet.

Oil Supply Schedule

Price Per Barrel	Barrels Supplied Per Week
$ 1	100
4	300
8	700
12	1,300
16	2,100
20	3,100
24	4,300
28	5,700
32	7,200
36	9,100

On your graph there are now two curves: a supply curve and a demand curve. The upward or positive slope of the supply curve indicates a direct relationship between price and quantity supplied. The downward or negative slope of the demand curve indicates an inverse relationship between price and quantity demanded. (Remember the Law of Demand?)

2. Find the intersection point of the supply and demand curves. What price does this represent? $_________ What quantity?_________________ (approximate)
   Notice that this is the only price where quantity demanded is the same as the quantity supplied. This is called the market equilibrium price and quantity.

3. Look at your graph or the demand and supply schedules to tell whether there will be a "surplus" or "shortage" at each of these prices. The first one is done for you.

1 Energy and Economics: A Curriculum Unit for Senior High Schools. Joyce Gleason and William Walstad, Center for Economic Education, University of Nebraska-Lincoln, 1985.

Price	Surplus or Shortage	How many barrels
$ 1	Shortage	9000 (9100-100)
4		
8		
12		
16		
18	Equilibrium	Zero
20		
24		
28		
32		
36		

4. When prices rise above equilibrium, there will be a____________________(surplus or shortage). When prices fall below equilibrium, there will be a____________________(surplus or shortage).
5. Assume that in a market system, buyers compete with each other to get the products they need and that producers compete with each other to sell what they produce. No one controls the price. In this example, would you expect producers to raise or lower prices if the beginning price was $24 and a surplus existed?______________
   Where would the price probably settle? _________
6. If there was a shortage, would you expect the price to rise or fall? _______________
   Why? ________________
7. Imagine that most consumers in this example felt that the equilibrium price was unfair and too high. Congress decided to pass a law which did not allow the price per barrel to rise above $12. Now since price is controlled below the equilibrium, will there be a shortage? ________________
8. A few years ago when gasoline prices were controlled, shortages did occur. What are some possible ways to deal with this problem? Are any of these better than allowing prices to rise to very high levels? ________________
9. Suppose incomes rise, and everyone is willing to buy more oil at each price. Earlier we saw this caused the demand curve to shift right. That is, demand increased. What will happen to the equilibrium price and quantity when demand increases? ________________
10. Suppose oil producers decided to cut back the supply and offer less at each price. The supply curve shifts left. What will happen to equilibrium price and quantity when supply decreases? _____________

ANSWERS: (1) and (2) intersect at $18 and 2600 (3) Prices below $18 cause shortages, above $18 cause surpluses (4) Surplus, shortage (5) lower, to $18 (6) rise, some buyers want to pay more and bid prices up, this means sellers will supply some more until equilibrium is reached (7) Buyers demand 4300 but sellers are only willing to supply 1300 (8) Rationing tickets, first come-first served, restrict amount sold to each, illegal "black market" sales above legal price, sell by license number on different days, etc. (9) Both rise (10) Price rises, quantity falls

Exercise II: YOU CAN MAKE A DIFFERENCE

In order for students to more clearly understand utilities and rate structures, have students take notes on a lecture prepared from Activity 11 Readings. This is primarily a research and information-gathering activity. Once the research is completed, students can present the information and recommendations in reports and oral presentations to various community groups and organizations, newspapers, radio, etc.

PROJECT IDEAS

1. Distribute to students information in the appendices prior to gathering information. Discuss.
2. Have students contact the City Council or City Utility Board concerning how utility rates are determined in the community.
   a) The Board of Public Works, City Council, or Utility Board in your community is the rate-setting authority in that designated service area.
   b) The utility department in your community can give you figures on the cost of utilities and how rates are set. They can furnish overall totals of utility costs to the community.
3. Have students research the Utility Board structure, the process for appointment or election to the Board, how the Board functions, and who are the Board members.
4. Have students determine the process for public participation in rate-setting of utilities in your community.
5. Have students contact the Nebraska Municipal Power Pool, and/or the League of Nebraska Municipalities for additional information on regulation, rates, and participation processes.
6. Have students contact the company from which your community buys its power. This information demonstrates how cost impacts rates.
7. Have students attend meetings of the Utility Boards in your community to become more informed on energy issues.

Exercise II: INTERPRETING A CARTOON [2]

DIRECTIONS

1. Students will discuss the implications of the cartoon by answering questions on consumption and United States energy usage.

Symbolism: What does the word consumption mean?
Who does the man in the cartoon represent?
What does the saw represent?

Interpretation: What will happen in the picture if the saw continues to cut its circle?
What will happen if the U.S. continues to use energy too fast?

Exercise III: LOAD MANAGEMENT

DIRECTIONS

1. Have students read the article in the readings on "Load Management."
2. Refer to TEACHER BACKGROUND RESOURCES for further information on Load Management.
3. As a class or in small groups, students could:
   a) plan for load management in their community;
   b) contact city utilities for further information on load management;
   c) determine what their community is already doing in load management;
   d) contact city utilities for information on peak times in the community;
   e) investigate the causes of peak load in their community;
   f) determine what their community could do better pertaining to load management;
   g) launch a community awareness campaign on load management and its economic value to the community through in-school oral/written reports, school newspapers, or posters in schools. Students could submit articles to the local newspapers for publicity, or write letters to the editor, or prepare public service announcements for the local radio and/or TV stations.

APPENDICES

TEACHER BACKGROUND INFORMATION

A. REGULATION OF PUBLIC POWER IN NEBRASKA
B. OUT-OF-STATE POWER SUPPLY RESOURCES
C. POWER SUPPLY PLANNING—THE PROCESS
D. ALTERNATIVE RESOURCES—CONVENTIONAL AND SUPPLEMENTAL
E. ELECTRIC RATES
F. PROPOSED REGULATORY CHANGES AND IMPLEMENTATION
G. NATURAL GAS REGULATION
   i. Historic Natural Gas Regulation in Nebraska
   ii. Gas Regulation in Nebraska
   iii. An Overview of Rate Regulation

A. REGULATION OF PUBLIC POWER IN NEBRASKA

Nebraska is the only one of the 50 states in which all electric power suppliers are publicly owned. These suppliers fall principally into three categories.

First, there are more than 100 municipal electric systems. The majority of these systems today have distribution facilities only. The policy-making function of these municipal systems is vested in publicly elected or appointed city councils, utility boards, or village boards.

The other large grouping consists of the various public power districts, created under the provisions of Chapter 70 of the Nebraska Statutes. The policy-making functions of these suppliers are vested in directors elected by the citizens residing in the territory served by the district.

A smaller grouping of electric suppliers consists of electric membership cooperatives and two generation and transmission cooperatives.

2 Don Hesse, Copyright 1974. St. Louis Globe Democrat. Reprinted by the Los Angeles Times Syndicate.

The electric suppliers of Nebraska have one common feature: the absence of a profit motive from their operations. Any benefits derived from a particular system are returned to its customer-owners in the form of lower rates and reliable electric service.

State Regulation

All of Nebraska's electric suppliers are required to meet the safety regulations of the Nebraska Public Service Commission and the National Electric Safety Code. In addition, electric suppliers with generation facilities must meet the requirements promulgated by the Nebraska Environmental Control Department.

The most expansive authority exercised by a state agency is that vested by statute in the Nebraska Power Review Board. The authority of the Nebraska Power Review Board is derived principally from Chapter 70, Article 10, of the Statutes of Nebraska.

By law each electrical supplier in the state has been required to enter into retail service area agreements which define the particular area each supplier is entitled to serve. If such agreements cannot be reached, the Power Review Board, after formal notice and hearing, has the authority to establish retail service area boundaries.

The Power Review Board has continuing jurisdiction to resolve service area disputes between suppliers. The Power Review Board also has continuing jurisdiction over large transmission and generation facility construction.

Prior to the construction of any generation facility, a formal detailed application to the Power Review Board is required, together with notice and hearing at which time all aspects of a given application are considered in detail to ensure that such construction is in the public interest.

The authority exercised by the Power Review Board over the last 23 years has been a very positive factor in reducing or eliminating service area disputes, wasteful competition between suppliers and duplication of facilities, all to the benefit of the rate-payers of Nebraska.

Federal Regulation

A number of federal laws and regulations impact on operations in Nebraska. In the case of nuclear operations, the Federal Energy Regulatory Commission exercises extensive jurisdiction. In addition, Nebraska entities, in many cases, are affected by the Federal Environmental Protection Agency, the Equal Employment Opportunities Commission and the Interstate Commerce Commission.

Legislative Authority

The ultimate regulatory authority exercised over public power in our state is that vested in the Nebraska Unicameral.

B. OUT-OF-STATE POWER SUPPLY RESOURCE

Laramie River Station	227 MW
Western Area Power Administration	785 MW
Basin Electric Power Cooperative	See Note I
Mid-Continent Area Power Pool	See Note II

NOTE I: The amount of capacity available is based on the annual peak demand of the load that Tri-State Generation and Transmission serves in Nebraska.

NOTE II: Certain public power districts have contracts of varying lengths in effect with utilities that are members of the Mid-Continent Area Power Pool (MAPP).

C. POWER SUPPLY PLANNING—THE PROCESS

One of the first requirements in undertaking a power supply planning study is the development of an orderly set of postulates and procedures to be used by the study participants. This is accomplished by dividing the study into five distinct components and reviewing the results of each component as it is completed. These five components are listed as follows:

1) Load Model Methodology - Establishing a load model representing the combined loads for all utilities participating in the study.
2) Resource Assumptions - Developing the assumptions for the existing and future alternative resources to be utilized in the study.
3) Optimization Studies - Developing an optimal base case generation expansion plan.
4) Sensitivity Studies - Conducting sensitivity studies on the base case assumptions to determine the effects on the base case generation expansion plans.
5) Analysis and Conclusions - Presenting the results and the conclusions of the overall study.

The methodology associated with each of these components is discussed as follows:

Load Model Methodology

In order to develop the load model, the individual participants provide forecasts with sufficient detail to determine a composite load on a seasonal basis. This requires that demand and energy projections for each utility be prepared on a seasonal basis. It also requires each participant to provide the relationships for each of their monthly peak demands to the summer peak demand and energy consumption for a typical week. From this information, a computer model representing the area load is developed, and sufficiently detailed seasonal information is determined, to reflect energy usage and thus be used to model the economic dispatch of generating units to supply that energy.

There are some resources that are common throughout the study period and in some cases these are handled directly as reductions from the load model. Specifically, the purchases from Western Area Power Administration are handled in this manner; this resource is predictable depending on the load level. Therefore, in modeling, it is possible to remove the load served by these resources since their contribution to meeting load is known beforehand and is not dependent on any other resource that may or may not be available.

Resource Assumptions

The next step in the power supply planning process is to develop a set of resource assumptions to be used in developing a base case generation expansion plan. This requires all participating utilities to submit detailed information on their existing and committed resources. This information should include estimated fuel costs, operation and maintenance costs, escalation factors for these costs, and availability of their units. This data is then compiled into a computer data base. Future resources are added, as determined by the computer model, to reliably meet the load requirements as well as provide the most economic expansion plan for the study period.

After data on the existing and committed resources are compiled, a shopping list of future alternative resources is developed for use in the computer model.

Cost and availability information for each of these resources are then prepared by each study participant and merged into a consistent set of assumptions for the resource alternatives. The information developed includes the construction cost of the facilities, the carrying charge rate to be used for the annual cost of the facilities, the fuel cost, the operation and maintenance cost, and the escalation rates for each of these components. Additionally, the length of maintenance periods and the assumed forced outage rates of units are developed to model resource availability.

Optimization Studies

The Westinghouse Electric Corporation Optimized Generation Expansion Program (OGEP) is used by the Nebraska Power Association to develop hundreds of possible future expansion plans from combinations of future unit additions available from the shopping list that, together with existing capacity, meet the projected load requirements and satisfy the reliability criteria. For all the possible expansion combinations available, the program then calculates the total present-worth production plus capital costs over the study period. The optimal expansion plan is generated out of hundreds that result in the minimum total present-worth cost over the study period and yet meets the load growth requirements as well as satisfies the reliability criteria (minimum 15 percent reserve margin).

Sensitivity Studies

There is a degree of variability in the base case data assumptions, therefore, sensitivity studies are conducted in order to ensure that the base case expansion plan continues to be reasonable under a change in assumptions or could be readily adapted to accommodate changes that might occur as time progresses.

Analysis and Conclusions

Finally, the results of the power supply planning study are analyzed and summarized in such a manner that the conclusions and recommendations can be presented.

D. ALTERNATIVE RESOURCES – CONVENTIONAL AND SUPPLEMENTAL

The Nebraska utilities have evaluated a variety of resource alternatives to determine the optimum plan for additional resources to meet future load growth. Many alternatives have been eliminated due to high cost, technical deficiencies, scarcity of fuel or resources, and the National Energy Policy. The Nebraska utilities actively promote the development of alternative and renewable generation resources. Only a portion of the alternative or renewable generation resources can be considered to be capable of providing firm dependable capacity, and most will contribute only energy when available. Therefore, the utilities have included coal-fired, pumped-storage and combustion turbines as possible future resource alternatives for providing Nebraska's firm energy requirements.

For each resource alternative, the following discussion describes the potential for Nebraska, principles of operation, present state of development, current test projects, advantages, anticipated costs, and summaries of their prospects. Particular attention has been devoted to the types of resources that have near-term potential for meeting Nebraska's future additional power requirements.

It should also be noted that the planning process is continual and that as changes in the alternatives resource picture become apparent, these changes or perhaps additional resources will be incorporated into the planning process.

Coal

The Nebraska utilities have studied the advantages and disadvantages of coal-fired generation and have selected it as one of the alternative methods of providing for immediate energy requirements. Coal is our country's most abundant fuel and is one of Nebraska's most economical fuel choices. The use of coal is consistent with the national energy policy and goals for energy self-sufficiency.

Conservation

Since the early 1970s, Nebraska homes, businesses and institutions have reduced their energy use by implementing energy efficiency improvements. As a result, energy consumption has been reduced.

Increasingly, end-use efficiency is recognized as a source of power. Amory B. Lovins, a physist and author, coined the term "Nega-watts" to describe conservation's ability to supply energy. When energy consumption is reduced, additional energy is available. Many utilities, including the Bonneville Power Administration, promote conservation efforts by their customers in order to delay the need for building additional generating plant. In that way, efficiency becomes a power source[3].

And efficiency has already proven its ability in this regard. The 125 million refrigerators and freezers in operation today require the electricty from 30 standard 1,000 megawatt power plants. If they were as inefficient as the average 1975 model, they would require 50 power plants.[3]

Oil

Some Nebraska utilities still consider the use of oil as a fuel for future peaking units. The advantages for using this type of generation to meet peak loads are apparent. Combustion turbines have a relatively low investment cost, can be installed in short time, and are able to burn oil, natural gas or other synthetic fuels in their operation. A disadvantage of this type of generation is its reliance on a scarce, as well as costly, fuel source.

Oil-fired base load generation is not a viable option due to fuel usage restrictions by government regulations, high fuel cost, and supply uncertainty. Therefore, the Nebraska utilities have eliminated oil-fired generation as a potential resource to meet new base load growth.

Hydroelectric

Hydro energy is generally considered to be non-polluting, renewable, and economically and technically feasible, depending on the particular site. Small hydro units are being recognized as a possible source to meet a portion of future energy needs. However, the Nebraska potential is not sufficient to have a significant impact on the total future energy requirements of the state.

Pumped Storage Hydro

Pumped storage hydro is nearly the exclusive means of energy storage today. Pumped storage involves pumping water to an upper reservoir during periods of low demand and releasing it through a reversible pump-turbine for generation during periods of high demand. A pumped storage plant has long life, is reliable, and has low operation and maintenance costs. Factors such as significant natural water flow and inexpensive base load generation for pump-back energy make pumped storage more attractive.

Pumped storage provides peaking capacity but requires more energy for pump-back than it produces while in the generation mode of operation. Energy required for pumped storage pump-back would increase the need for energy from plentiful coal and nuclear fuel for oil and natural gas. Pumped storage currently appears to be the most feasible and economical means of supplying peak energy and is therefore included as an alternative.

Solar

Solar energy is currently the most discussed new method of energy production. It is defined to include thermal and photovoltaic electric generation, wind, and biomass produced energy.

Thermal

A number of solar thermal generation methods are being studied throughout the United States. One solar thermal system operates by concentrating the sun's rays via mirrors called heliostats on a central receiver. The heat produced at the central receiver is used to boil water and produce steam. Thousands of heliostats which cover a large area are required to produce a significant amount of

3 "Energy Efficient Buildings" Arthur H. Rosenfeld and David Hafemeister Scientific American, April 1988, p. 78.

heat. The first solar thermal pilot plant is scheduled to begin operation in the mid 1980's near Barstow, California, and will produce 10 MW.

It appears at this time that the 100 MW to 300 MW range will be the most economical size for commercial plants. It is hoped that several demonstration plants of this size can be put into operation in the United States sometime after 1985. The current installed cost for solar thermal is approximately $3,000/kw. It is hoped that the cost for the first plants will be slightly less than $2,000/kw which is still quite costly since storage or backup would be required.

Photovoltaic

Photovoltaic conversion produces energy directly by sunlight focused on semiconductor thereby producing a charge. A major limitation of photovoltaic- produced electrical energy is its very high cost of over $7,000/kw. This cost will be reduced by more advanced technology, mass production, and the use of concentrators.

Solar electrical generation, although technically feasible, is not yet cost competitive. If large scale solar generation does become economically practical, it most likely will be in the southwest. In addition to cost, another disadvantage is that while solar generation produces energy, it does not provide predictable capacity. This requires that capacity backup from conventional sources of generation be available.

Wind

The wind has been used to produce mechanical energy for hundreds of years. Small-wind driven generators were used in many rural areas in the late 1930's and 1940's. An interest in producing electrical energy using the wind has grown in recent years. The technology for wind generation is simple and has been known for some time. Rotor blades, turned by the wind, are connected to an alternator by couplings and gears and thereby produce electricity.

It is generally believed that wind energy will be the first of the solar electric technologies presently under development to emerge for serious consideration as a utility power generation source. Development of large-scale wind generation has only begun in the past several years. There are operational problems to overcome and substantial data to be collected before wind energy can be adequately studied as a resource alternative for Nebraska utilities.

Biomass

Biomass generation involves the production of electrical energy using wastes, residues, or crops as fuel. These fuels can be used for primary fuel for a power plant, or to supplement coal or petroleum products by either direct combustion or processing into grain alcohol.

Limitations and costs for biomass generation vary considerably depending on the fuel type and location of a particular plant. General feasibility of the use of biomass as a fuel in Nebraska has not been established. However, specific projects, as they are studied, could become sources of supplemental fuel for coal-fired plants. This type of generation is expected to become economically feasible, with few technical problems, particularly when sufficient quantities of fuel can be produced or the expense of waste disposal becomes too high.

Cogeneration

Cogeneration is the utilization of waste or unused heat, usually taken from a manufacturing process, for a useful purpose such as electrical generation. Considering the cost of energy, it is advisable to seriously investigate and consider utilization of unused heat for power generation or other useful purposes wherever practicable.

The Nebraska utilities continue to support cogeneration. However, there are relatively few large industrial customers within Nebraska, so there is limited opportunity for predictable growth from cogeneration. Cogeneration will continue to be studied but is currently not expected to have a significant impact on the future electric requirements of the state.

Combined Cycle

A combined cycle plant is a method of cogeneration and consists of a combustion turbine and a conventional steam turbine which is powered by steam produced from the exhaust heat of the combustion turbine. A combustion turbine uses expensive fuel rather inefficiently, and a combined cycle configuration can substantially increase this efficiency. A combined cycle plant can add feasibility to a utility's resource mix and thereby cut the overall costs of generation. It can often serve mid-range duration loads economically.

Natural Gas

Natural gas has basically the same restrictions as oil. Government regulations, cost, and unreliable supplies do not allow the use of this option in any new electric power plants.

Coal Derivatives

Synthetic fuels production, particularly from coal, has recently received strong support in the fight for energy independence. It currently appears that of the new synthetic fuel technology, coal gasification may make the strongest contribution to fuel supplies in the near future. Information and cost projections indicate that coal gasification, although technically feasible, is not economically competitive with natural gas.

Fuel Cells

Fuel cells produce electrical energy directly by chemical means. They hold significant promise for utilization, particularly if coal gasification is successful. Test models currently use methane or a liquid hydrocarbon.

Fuel cells offer the advantages of efficiency, flexibility, and environmental desirability. They also require no cooling water which is important in Nebraska. Operational problems and the ultimate cost of fuel cells are still unknown. It appears that they will at least have some potential for providing peaking capacity.

Load Management

Load management can also be considered a resource alternative. Whereas load management does not provide a direct capacity or energy contribution, it can provide for an additional generation of resources. Through load management, summer peak demand requirements can be reduced or controlled to some degree, thereby providing for a possible deferral of additional peaking capacity resources. Some of the Nebraska utilities have already experienced reduced summer peak demand requirements as a result of managing irrigation load and this managed load has provided for the deferral of new generation capacity. The Nebraska utilities recognize the positive economic benefits that could result from the management of summer peak demands and are actively investigating and instituting various techniques for load management. They have initiated several load management programs, which are based upon economic incentives, public education, research, and cooperation with other utilities.

Some economic incentives that are currently used are: seasonal rates to reflect the higher cost to meet summer peak demand; and off-peak rates for irrigation and industry to reduce summer demands. There has also been some testing of time-of-day rates and the effects this rate structure can have on summer peak requirements. The testing of time-of-day rates will continue but in many cases will be tied to some direct load control system.

Public education on the wise uses of electrical facilities is also an important aspect of load management. Many utilities have held meetings with their customers, which are in some cases other utilities and in some cases the ultimate consumer, to advise them of the effects that load management may have on their expenses and operation. This has usually been done with larger customers on a one-to-one basis in meetings and through more general advertising for the smaller residential or commercial customers. However, with the advent of the home energy audit program, the smaller customers are becoming even better educated as to their electrical usage. These programs are expected to continue.

Research is an aspect of load management which is also important since this is the primary method of learning what the technological problems are with some of the equipment, what effects various programs have on electrical loads, what the cost of equipment may be to obtain a given load reduction, and what generation cost savings could result from the load reductions.

In order to determine possible technological problems, various methods of controlling loads have been or are now being tested. These include: radio control to cycle air conditioning and water heaters; telephone communication systems for remote metering and cycling of air conditioners; and using "whole house" load limiters to keep peak requirements of that customer below a predetermined level.

Load research is important and many of the utilities are involved in research of their customer requirements both with and without load management by direct control. Pilot load management programs are more common now so that the effects of load management can be better defined. This work started in the late 70's and has been intensifying since then. The primary candidates for load management have been irrigation and air conditioning with some research being done with water heater controls.

Additional research has also been conducted to determine the types of appliances or loads that the individual customers have in order to determine saturation levels of appliances. This, along with additional data, will be utilized as tools to help refine the forecasting techniques that are now in use as well as to determine system effects of controlling specific appliances.

E. ELECTRIC RATES

Designing Rates

Despite recent increases, electric rates paid by

Nebraskans continue to be well below the national average. Every effort is being made to keep the rates in the nation's only wholly public power state as low as possible.

The Cost of Service approach is utilized as the methodology for pricing of electricity in the State of Nebraska. The Cost of Service approach in the electric utility industry has emerged in recent years as the most generally accepted method both in the public and private sectors for ratemaking. A Cost of Service approach is defined as the procedure of determining the costs to provide service to the various customer classes of the utility. Having determined the associated costs to provide service, rates can be designed which are related to those costs.

Generally, the following goals and objectives are employed by electric utilities in Nebraska in the design of electric rates:

1. Rates should be designed to produce the required revenues.
2. Primary consideration in rate design should be given to the costs incurred by each customer class in serving the class.
3. The rate structure should contain the attributes of simplicity, public acceptance, understandability, and feasibility of application and administration.
4. Rates should reflect stability to the degree possible both from a year-to-year system-wide basis and from fluctuations within a class from rate period to rate period.
5. Rates should reflect the type and quality of service required by the customers.
6. Rates should be developed so as to avoid discrimination between customers.
7. Rates should be designed to develop efficient use of the utility's capacity.

Cost of Service studies are widely accepted as a principal tool for rate-making by the Federal Energy Regulatory Commission (FERC), by various state regulatory commissions, and by most rate analysts. The Cost of Service standard is held to be a fair test of reasonableness in rate-making. The reasons why the Cost of Service approach is deemed an appropriate method for rate-making in the public utility sector of the industry are the following:

1. Because of the large amount of investment costs required by an electric utility, economics dictate that natural monopolies tend to exist. Cost of Service studies and resulting cost-based rates help assure that the price of electricity to each class of customer results in a fair, reasonable, and non-discriminatory charge.
2. Pricing of power and energy at cost-related prices will help assure an efficient usage of limited energy resources.
3. Public power entities in Nebraska are instituted to provide electric service to the ratepayers of the state at the lowest rate consistent with the cost of providing such service. Recovering revenue by charging cost based rates appeals to traditional tests of fairness and equity in rate design and provides a measure of equitable rate treatment.
4. Under the principle of consumer sovereignty, the customer should be free to enjoy the service in the amount desired as long as the utility is reimbursed for the cost to provide service.
5. The pricing of electricity at cost should bring about the proper control of demand in that if rates are equal to costs, consumers are put into a position of self-rationing because they will strike a balance between the benefits received from electricity versus the costs imposed by purchasing electricity. If rates are lower than costs, service would be supplied in wasteful amounts. If rates are greater than costs, electric service would be unduly restricted in an economic sense.
6. Under the principle of the compensation standard of the income distributive function of rates, when the customer with a given income demands from the utility a certain amount of a public utility service, the consumer should surrender to the utility the cost equivalent opportunity to use his cash income for the purchase of other goods and services. Thus, the consumer who receives the benefits of the service should bear the cost burdens.
7. The Cost of Service approach tends to provide better pricing stability and predictability compared to other pricing methods.

Classes of Customers

In the case of the electric utility industry, no two customers have exactly the same load and service requirements. In theory, it would be appropriate that every customer of the utility be examined as to load and service requirements and an individual rate be designed which would recover from the customer the costs incurred in providing such service. As a practical matter, the operation of a utility as a business, the utility with thousands of customers cannot survey the needs of each customer and set individual prices. Therefore, it uses the next best approach. It groups together those customers who have similar service requirements into service classifications.

A cost analysis is the principal tool available to utilities in determining the rates to be offered to various classes of service. Each component of the utility's system is analyzed and a determination is made as to its use by various customer classifications. In this manner, the rates charged to each customer class and individuals within the class will produce the class revenue requirements. When the revenues for all the customer classes are combined, the total revenue will be sufficient to cover the costs of providing service.

Electric rates for each class of customers generally consist of three cost-related categories:

1. Capacity or demand-related costs include investment costs (debt service) on facilities, demand portion of purchased power, and the operation, maintenance, administrative and general expenses related to the utility plant. Capacity-related facilities generally include generating facilities, transmission, and a portion of the distribution facilities. (Costs per kilowatt of demand.)
2. Energy-related costs which refer to those costs which change as the production or consumption of energy varies. Examples are fuels used in the generation process and the energy portion of purchased power. (Costs per kilowatt-hour of usage.)
3. Customer-related costs which refer to costs dependent on the number of customers served by the utility and are generally independent of energy and demand requirements. Examples include customer billing, and meter readings.

Minimum Billing

Many utilities in the state employ time differentiated rate periods. The most commonly used in Nebraska are winter/summer rates. The principle behind this theory is that the highest demand for electricity in Nebraska occurs in the summer and the class of customers that most heavily contribute to this summer peak demand should be assessed the costs associated in providing this high demand.

Since utilities must plan to have available sufficient resources and transmission facilities to meet the seasonal peak demands, wholesale suppliers in Nebraska have implemented a minimum billing or "rachet" charged to customers to be applied to wholesale billings during the months of the year when the peak demand is not reached. The charge is necessary to make sure there is enough power available to meet peak demands during the irrigation and air-conditioning season. The ratchet charges amount to 50 to 100 percent of the peak use reached during the summer months depending on the utility. Even if a utility's demand during any month falls below that percent of its one-month peak demand for a one-year period, that utility is obligated to pay the wholesaler that percentage of its one-month peak demand.

Similar charges are made by wholesalers in other high peaking states whether it be summer or winter.

Fuel Adjustment Charges

Like almost all public and private electric utilities across the nation, Nebraska's public electric utilities have in effect a production cost adjustment which is sometimes called a production cost factor, fuel adjustment charge, fuel adjustment clause, or pooled energy adjustment.

The charge is an additional segment of the electric billing which reflects current increases or decreases from the standard rate base cost of fuel used in the generation process or purchased power. It is a pass-through charge for the utilities that compensate for the variance in fuel prices.

The charge became widely used in the early 1970's when fuel prices, like everything else in the economy, began increasing at rapid inflationary rates. There was no way utilities could predict the cost of fuel for an entire year. Wholesalers pass the charge onto their customers and most retailers also pass the charge onto consumers through a "factor" on the electric bills. The charge can either be on a year-long estimated factor basis or may fluctuate from month-to-month.

Because of more stable fuel prices and the state's "mix" of power resources, factors in recent months and years charged by some of the state's wholesalers and retailers have actually been credits to the electric bills rather than additional charges.

Billing Content

Although retail electric bills to Nebraskans vary from utility to utility, most of them display the dates of the last meter reading and the present reading; the previous meter reading and the present meter reading; kilowatt-hours consumed during the billing period; charges for electric and other service; credits; applicable sales taxes; and total amount due for the billing period. In addition to the production cost factor listed on the bill, some utilities also include the kilowatt-hour consumption corresponding to the same billing period a year earlier. A comparison of kilowatt-hour consumption may help consumer determine their electrical usage patterns.

Metering
In cities and villages it is common for retailers to conduct meter readings as part of the service offered; however, in rural areas it is not uncommon for rural power districts and cooperatives to require customers to read their own meters. Billing periods vary from utility to utility—monthly to annually.

An electric meter records the number of kilowatt-hours of electricity used during a period of time. Electric bills are figured from the number of kilowatt-hours consumed. Most customers pay for electric service after it is used.

Energy Rates
Since 1976, electric rates in Nebraska have increased at a much slower pace than the rates for other commonly used fuels. Although electric rates vary considerably, generally speaking, they have increased less than the rate of inflation during the same period of time.

For most retail customers in the state, electric rates have increased between 60 and 70 percent since 1976. During that same time period, average natural gas prices in the state have gone up approximately 205 percent, fuel oil prices have gone up approximately 229 percent, and propane prices have increased approximately 150 percent.

Nebraska's public electric utilities foresee much smaller rate increases during the next several years compared to the increases of the late 1970's and early 1980's. This is due primarily to the fact that additional generating resources will not be needed in the state until at least the next century.

F. PROPOSED REGULATORY CHANGES AND IMPLEMENTATION

In lieu of competition (e.g., competing gas companies), responsible regulation is necessary and advisable. With the importance of conserving our natural and monetary resources, the duty to regulate responsibly becomes compelling.

Suggested Implementation
Ordinance Adoption: To implement the concepts previously discussed requires preparation and adoption of an ordinance. Your city attorney will assist you in the preparation of the necessary ordinance(s) although he/she may want some assistance from experts in the area of rate evaluation and design.

Also, bear in mind that one is talking about responsible regulation—not denying rate increases just because it is politically expedient at the moment. Gas companies must be allowed a reasonable rate of return of their investment so that the system is safely maintained on an on-going basis. But how would you explain to the retired neighbor couple next door that you allowed the gas company a substantial return on its investment and did not even investigate it? Each request by the company must be judged on its own merits.

G. NATURAL GAS REGULATION

Each year Nebraska spends more than $500 million for natural gas purchases, whether for heating homes, running industrial operations or drying grain. Although natural gas purchases return many benefits to our economy, they also represent a direct pipeline out of our communities since up to 80% of the natural gas dollar is exported to other states or Canada to pay for the costs of importing the natural gas which we consume.

As with other utilities, natural gas service is a regulated monopoly since the costs of providing service are too great for normal competition among natural gas suppliers to develop in our communities. In Nebraska, the role of regulating the price of natural gas has been given to the local City Councils and Village Boards.

Competition in the Market Place
Why do we even have to worry about regulation? Is this country not founded on the principle of competition wherein we are free to set our own prices and let the consumers decide whether or not to purchase our product? Is this another form of ever-pervasive government interference in our lives? To understand the need for regulation, one needs to understand the difference between essential and non-essential goods and services, and also the investment required to construct and operate a public utility. We are normally offered several options when we go to purchase a car, groceries, etc., as there are several suppliers and we are free to choose based upon price, quality of service, or any other criteria which we value as important to the decision. Those producers, manufacturers, and suppliers which provide the products or services which we desire most often will likely be successful and shall remain to serve us in the future. Additionally, competition will essentially set the price for the products and little, if any, outside regulation is required. Those products which are overpriced, as compared to the competition, will likely disappear from the marketplace.

Regulation of Monopolies

There are some businesses which are so expensive to construct or operate that it is not practical to have competing services. Most of our public utilities are in this category. Utility systems are expensive to build and imagine the confusion in the streets if there were more than one gas company, several water and sewer systems, or multiple electric systems. It would be both impractical and expensive [4].

But not only are utilities expensive to build and maintain, they are "essential services". We must have water and sewer, electricity and, in most instances, natural gas to maintain our lives and businesses. Thus we are left in the position of having needed services but without the price and quality protection of competition of the marketplace. How is the rate payer to know that he/she is receiving reliable and responsive service at the least possible cost?

In Nebraska, rate payer protection is generally accomplished quite adequately by public ownership of the utilities. Essentially all water, sewer, and electric systems of any consequence are publicly owned. Regulation is achieved by election of the governing bodies of the utility, normally a city council or village board, but in some instances, elected boards such as for a public power district. Citizens and rate payers can readily participate in the governing of the utility by appearing before the local board or by being elected to the board itself.

But regulation of an investor owned utility is not so simple and straightforward. With the exception of the nine municipally owned gas systems in the state, the natural gas companies are privately owned and thus are primarily responsible to their stockholders and corporate boards of directors.

Thus, in the absence of competition, most states choose to have some form of statewide regulatory authority over the utility. This is normally in the form of a Public Service Commission, Corporation Commission, Railroad Commission, or a similar body. The purpose of the authority is to set the guidelines and rules, hold rate hearings as required, and to generally oversee that the public need is protected.

In general, it is very costly to staff and maintain these commissions and the hearings can be very costly [5]. Local control is generally lost in these proceedings as the regulators may have different goals than either the local rate payers or the companies.

Nebraska has chosen to avoid this costly and controversial solution by leaving control of the gas utilities with the local governing boards and councils. Whether this will ultimately be judged a successful means of regulation will depend in large measure on what tools are put at your disposal and how well the tools and authority are exercised.

A graphically illustrated sketch of the typical regulatory system in other states and in Nebraska will show that competition may be an increasingly important factor in the regulatory scheme. As natural gas prices continue to climb, one can logically expect competition, not from other systems, but rather from other energy sources such as coal for industry and electricity for home heating.

Gas Regulation in Nebraska

The authority for gas regulation in Nebraska, as we have previously seen, is vested in the local city councils and village boards.

The legislature has put some limitations on the governing body by requiring that the city council or village board take final action within 90 days of the filing of the application for a rate modification, and allowing the gas utility to petition the courts in the event the council or board fixes a rate other than that proposed by the utility. However, in this regard, two very important rules should be noted:

1. Gas rates fixed by a city or village for a utility company are presumed to be correct and reasonable and the burden is on the utility company to show that they are clearly, palpably, and grossly unreasonable.
2. The ordinance dealing with gas regulations is presumed to be reasonable. When attacking it (the utility) has the burden of proving that it is unreasonable. If there is a doubt as to its reasonableness, the ordinance must be sustained. If the question of reasonableness is seriously debatable, the opinion of the municipal governing body, not that of the courts, must prevail.

It should also be noted that a public utility is entitled to rates for its service that may normally be expected to yield a fair return upon the reasonable value of the property that is being used for the public convenience. Also, there is no requirement nor presumption that rates should be substantially equal in all Nebraska municipalities, or between rate classes.

It is quite clear that a municipality's authority and control over natural gas utilities operating within the municipal boundaries is substantial and must be exercised with care and responsibility commensurate with that authority.

4 Valentine, Nebraska has no natural gas system. There are a few small, privately owned water, sewer, and electric systems in the state.

5 Wyoming utilities are assessed over $2,000,000 per year for the operation of the Public Service Commission.

Municipalities in Nebraska are responsible for regulating natural gas utilities within their municipal boundaries. The procedures that a municipality must follow were established by the Nebraska Legislature when it enacted by the Municipal Natural Gas Regulation Act in May, 1987.[6]

Principals of Utility Regulation

The basic principles of utility regulation are:

- The opportunity to earn a fair rate of return by a utility;
- Rates must be just and reasonable;
- Property on which the utility may earn a return must be used and useful in providing utility service; and
- Costs upon which rates are based should be representative of the period for which rates are being set.

Municipal Regulation Under the Act

Municipalities are required to regulate natural gas rates under the Act. There are five different regulation procedures under the Act:

- Setting rate area boundaries;
- General rate changes;
- Municipally initiated rate changes;
- Supply-cost-adjustment ordinance; and
- Supply-cost-adjustment compliance.

Setting rate area boundaries

Regulation of natural gas utilities by municipalities is aided by the establishment of rate areas within the state. A rate area is defined as the municipalities within a geographic area within the state "served by a single utility through a common pipeline system from the same natural gas supply source" in which "the utility has similar costs for serving customers."[7]

General rate changes

A general rate change involves a change in the cost of providing natural gas service to customers other than natural gas supply costs. In a general rate change, a governing body is responsible for setting just and reasonable natural gas rates within its jurisdiction.

Municipally initiated rate changes

A governing body of a municipality has the right to initiate a proceeding for the review and possible adjustment of a utility's natural gas service rates once in any thirty-six month period.[8]

Supply-cost-adjustment ordinance

A natural gas supply-cost-adjustment rate ordinance allows for the adjustment of consumer rates caused by fluctuations that occur in the cost of purchasing natural gas by a utility. A natural gas supply-cost-adjustment ordinance should reflect the changing costs of purchasing natural gas.

Supply-cost-adjustment compliance

A review by the municipality of an existing supply-cost-adjustment filed under the municipal ordinance may be done periodically to ensure that the utility is accurately implementing the municipality's current supply-cost-adjustment ordinance.

Municipal Loan Fund

A revolving loan fund has been established by the state and is available to municipalities in a rate area to pay for the costs of regulating natural gas utilities.[9] Only one loan for the rate area is available to encourage all municipalities in the rate area to combine their efforts and to minimize the costs of regulation to consumers. The loan is required to be repaid by the utility which may levy a surcharge on its customers.

 6 Neb. Rev. Stat. Sec. 19-4601-4629. 7 Sec. 19-4602 (13). 8 Sec. 19-4618. 9 Sec. 19-4617.

The following audiovisuals are available for free viewing from the Office of Energy and Economic Education, 307 College of Business Administration, University of Nebraska-Lincoln, Lincoln, NE 68588-0402. (402) 472-5612/2333.

The Kingdom of Mocha. (27 minutes, color) An animated video that provides an entertaining introduction to basic economic concepts. Mocha is an imaginary island that undergoes rapid change as its economy develops from primitive barter to a more complex system.

Return to Mocha. (28 minutes, color) An animated video that illustrates several economic concepts in greater detail. The Mochans, now living in a more advanced economic society, enter into international trade agreements which allow them to interact with other economic systems.

Energy Savers. (10 minutes) Goofy, Donald, Mickey, and Pluto learn how to save energy around the house. As the four friends demonstrate wise and wasteful uses of energy, the narrator describes energy-saving tips for lighting, cooking, washing, heating, and cooling. (Walt Disney, 1982)

Fields of Fuel: The Ethanol Debate. (28 minutes) This film explores the potential of converting crops to fuel. It examines the production and utilization of ethanol on both small and large scales, emphasizing the issues that will determine ethanol's future as a fuel source. The need for cooperation by government and American automobile industry representatives is stressed. (Iowa State University, 1980)

All About Insulation: (15 minutes) General Audience. Information about R-Values, vapor barriers, and "how to" install batt insulation in the home. (Owens Corning Fiberglas)

Backyard Alternative Energy: (28 minutes) Jr. High-Adult. An informal report on innovative, small-scale alternative technology projects being developed by Americans. Highlighted energies include wind, water, solar, wood, geothermal, methane, methane steam, compost, and horse power. (Centron Films, 1978)

The Brookhaven House: (25 minutes) 7th-12th Grades. A facinating record of the construction of the Department of Energy's prototype passive solar home, built with standard techniques and materials. Shows how anyone can adapt standard housing designs to incorporate passive solar features. There is animation to explain the energy flows in the hours and typical floor plans. (Dept. of Energy)

Don't Cut Us Off: (15 minutes) Jr. High-Adult. Documents the activities of four communities to solve a common national problem of high energy costs as it affects the poor and elderly.

The Double Nickel Challenge: Examines the economic and conservation benefits of carpooling and following the 55 mph speed limit. (Byron Color Correct Prints)

Energy: The Great Escape: (Encyclopedia Britannica Educational Corporation)

Feather Foot: (30 minutes) Jr. High-Adult. A question and answer format which provides the basis for you to analyze your knowledge about driving and how to improve fuel efficiency in driving. (Honeywell, 1976)

Grass on the Roof: (28 minutes) Jr. High-Adult. A film about earth-sheltering housing. Principles such as the use of thermal mass and passive solar heat are discussed.

Great Search for Power and Energy: (13 minutes) 1st-7th Grades. This is the story of man's discovery, development and application of the major sources of energy using animated characters. A humorous account of how man gradually discovered and harnessed various energy sources. (Walt Disney, 1980)

Harness The Wind: (12 minutes) 4th Grade-Adult. A concise overview of the history of wind power with brilliant animation. Shows the gradual refinement of wind machines. Projects wind's potential in our future energy mix. (The National Board of Canada, 1978)

Home Energy Check: High School-Adult. Helps homeowners check their homes's energy efficiency. Learn how simple home improvements can reduce their home energy consumption and costs by reducing home energy waste, and see how to install improvements they find are needed. (Time Films)

If You Can See a Shadow: (27 minutes) Views the simplicity, necessity, and the practicality of passive solar homes. In showing the partnership of conservation and passive, the film presents enough information for viewers to act on what they've seen. Included are sections on mass walls, sunspaces, combining passive systems, passive hot water, movable insulation, simple solutions, and passive underground. (Brewer-Reynolds Production)

Lovins on the Soft Path: An Energy Future With a Future: (36 minutes) 7th Grade-Adult. Energy consultants outline their analysis of the energy problem and tackle four questions: How much energy do we need; what kinds of energy; where can we get it; and where do we start. Using animation and charts, the film presents complicated information in a readily understandable fashion. (Rockey Mountain Institute, 1982)

National Solar Water Heater Workshop Presentation: (Arizona State University)

Nuclear Energy: The Question Before Us: (26 minutes) Jr. High-Adult. Discusses the nuclear energy process from mining to disposal of wastes while also discussing the costs, accidents, and economic costs. Includes teacher's guide. (National Geographic, 1981)

The Power to Change: (28 minutes) General Audience. A presentation of human scale solutions to significant social and economic problems. Addresses technology in the areas of solar heating, composting, wind-powered electrical generation, recycling, and more. (Appropriate Films, LTD, 1980)

Running on Empty: (27 minutes) Sr. High-Adult. Explains techniques and maintenance tips that can increase gasoline mileage while also explaining things that will make a car run less economically. (U.S. Department of Energy, 1978)

The Solar Film: (11 minutes) Sr. High. Traces our relationship to the sun in three separate episodes. It explores the formation and creation of the earth, traces our consumption of sun-created fossil fuels and returns to the sun itself as the logical sources of future power. (Pyramid Film and Video)

Toast: 3rd Grade-Adult. Illustrates our underlying dependence on fossil fuels, even in the production and distribution of a slice of bread. Using flowing images set to music, it documents all the fossil fuel inputs. (Pratt Audiovisual and Video Corporation, 1974)

What Energy Means: (15 minutes) 1st-6th Grades. Explores the meaning of energy while discussing the various energies and energy conservation. An introduction to kinetic, chemical, heat, light, sound and electrical energies. (National Geographic Society, 1982)

Why Should I Care: (24 minutes) General Audience. An illustration of energy efficient automobile driving techniques and the enemies of efficient driving. (Visucom Productions, Inc., 1979)

Coal: Solution or Pollution (3/4") (30 minutes) 7th Grade-Adult. Treatment of pros and cons of using more coal and the costs and benefits of pollution controls for coal-fired power plants. Covers environmental and economic issues of coal-burning pollution controls. (Synthesis Public Broadcasting, 1980)

Energy—The American Experience (3/4"): General Audience. The development of different forms of energy under the unique conditions of the American experience is shown. It demonstrates the 60-year changing cycle of energy sources from wood to coal to oil and gas that produced the steam and electrical energy that helped make the U.S. and industrial giant.

The Energy Challenge Series (3/4"): (4 parts, each 29 minutes) Part 1, Historical Perspective; The historical aspects of energy use. Part 2, Energy Use in America; Explores the uses of energy in society. Part 3, Community Energy Consumer; An in-depth look at consumers within the community. Part 4, Our Energy Future; Focuses on the subtle but drastic changes in energy using habits that are bound to take place in the next 20 years. (Cooperative Extension Service, UNL)

The Energy Store (3/4") (5 parts, each 28 minutes) 6th-10th graders. Part 1, Energy conservation, alternative energy sources, home energy audits and home energy savings. Part 2, Insulation, weatherstripping, solar greenhouse, wind generation and appropriate technology. Part 3, Cost effectiveness of home insulation, caulking, retrofitting, van-pooling and solar energy practices. Part 4, Wind power, passive solar devices, solar vs. conventional communities and energy conservation in the kitchen. Part 5, Heat pumps, active solar collection, fireplace efficiency, coal and energy savings in your home—a summary. (Nebraska Energy Office)

Energy and the Way we Live (3/4") (17 minutes) (Video Tape Association)

Extending Energy Efficiency (3/4") 2 parts, each 28 minutes (Nebraska ETV Network)

The Forgotten Fundamentals of the Energy Crisis (3/4") 55 minutes

National Solar Water Heater Workshop Presentation (3/4") Arizona State University

Oil Crisis of Catharsis (3/4") (30 minutes) A look at Nebraska's petroleum problems. Facts presented include U.S. consumption and production figures, and foreign imports. A look at renewable energy alternatives including solar. (Nebraska ETV Network, 1979)

Oil: A Crude Warning (3/4"). (27 minutes) Tells the past, present, and future story of oil in the U.S. followed by an overview of the current oil situation, with information on supply and demand, consumption levels, and industrial dependency on oil. The unifying message is "to find better ways to manage and maximize the oil we have left"—supported by facts and opinion from experts. (Washington State University, 1983)

Power Struggle (1/2") (50 minutes) General Audience. Narrated by Meryl Streep, the importance of choosing energy sources that are safe and economically sound is shown. It tells of the drawbacks of nonrenewable energies, focusing on nuclear energy. Reviews renewable energies of solar, wind, hydro, biomass, and more. Also stresses energy conservation. (Nebraska ETV Network, 1986)

Run With The Sun (3/4") (55 minutes) 9th Grade-Adult. A presentation of present and future states of solar energy and applications. Covers savings potential, need for weatherization, insulation, examples of systems, and drawbacks of solar energy. (Nebraska ETV Network, 1979)

Solar Water Heating (3/4") (48 minutes))Nebraska ETV Network, 1981)

Sunbuilders (3/4") (20 minutes) General Audience. Demonstrates techniques of passive solar heating-use of southern exposures, extending roofs to deflect summer rays, locating greenhouses and fireplaces to absorb the sun's rays that can cut heating bills, reduce dependence of fossil fuel, and provide a safe form of energy. (National Audio Visual Center)

FILM STRIPS WITH CASSETTES

Energy and Everyday Life (3 parts each 15 minutes) Elementary audience. Part 1, Sun, Wind and Water. Part 2, Energy From the Earth. Part 3, Saving Energy. Good introduction to energy, it's forms, and applications. Simply explained. (National Geographic Society, 1978)

Passive Solar House Design: Explains the concept of a passive solar house and demonstrates its contribution to the solution of the energy problem. It explores the basic design of a direct gain passive solar home and the unique ways that the sun can be used to heat the home. Includes a 20-question multiple choice test. (Bergwall Productions, Inc.)

The World of Energy: (3 parts each 15 minutes) 5th-9th grades. Part 1, Using Energy. Part 2, Fossil Fuels. Part 3, Energy in the Earth. (National Geographic Society, 1974)

This World of Energy II: (3 parts each 15 minutes) 5th-9th grade. Part 1, Our Energy Problem, Part 2, Nuclear Energy, Part 3, Sysnthetic Fuels and Other Alternative Sources. (National Geographic Society, 1982)

SLIDE SHOWS

Earth Sheltered Homes in Nebraska: 2 parts. A tour of some earthsheltered and earth-bermed homes in Nebraska. (Nebraska Energy Office)

Earth Sheltering: A look at earth sheltering applications throughout the U.S. (University of Minnesota)

Fort Calhoun/North Omaha Power Plants: (15 minutes) A tour through the Fort Calhoun nuclear and the North Omaha coal-fired power plants. (Nebraska Energy Office, 1980)

Home Energy Check —A Search for Savings: The importance to reduce heat loss by showing methods of insulating, caulking, and weatherstripping is covered.

Kirkwood Solar 80 — Building an Energy Efficient Home Using Passive Solar Energy: Sr. High-Adult. A project of the Kirkwood Community College, the objectives were to build a passive solar home that would be practical for the commercial market and reduce heating costs up to 80%. Shows steps of project. (Mid-American Solar Energy Complex)

Nuclear Energy: Peril or Promise: (2 Parts each 18 minutes) 6th-12th grades. Part 1, History of nuclear energy and its use as a possible alternative. Part 2, program presents the facts and dangers of nuclear energy as well as possible alternatives. (Science and Mankind, Inc., 1980.)

Passive Solar: A review of passive solar energy. Examines all types of applications. (Solar Energy Association and Nebraska Energy Office)

Renewable Energy Resources: Wind, Water, and Solar Rays: 2 parts, each 23 minutes. 7th-12th Grades. Part 1, focuses on biomass and solar space and hot water heating. Part 2, explores ways that water, wind and solar rays are now being used to generate electricity and looks at some new ways that may become commonplace. Gives information on cost efficiency, applications and pros and cons. (Science and Mankind, Inc., 1980)

Save Energy—Save Money: Depicts how everyone can practice energy conservation in the home and how energy conservation can save your family money. (University of Missouri, Columbia)

Solar Energy: The Quest and the Question: A look at solar collectors and a wide variety of buildings and homes using solar energy. (Solar Energy Research Institute, Golden, Co)

The Sounds of Energy—The Story About Energy for Nebraska: A general overview on the needs and suppply of energy in Nebraska and how Nebraskans might meet these needs in the future. (Nebraska Energy Office and University of Nebraska-Lincoln)

Window Design to Conserve Energy: (3 parts) Program illustrates exterior windows, frames and glazing, and interior window strategies that will help make windows more energy efficient. Techniques described are passive solar heating, daylighting, shading, insulation, air-tightness, windbreaks, and use of thermal mass and interior color. (National Audio Visual Center)

AUDIO-VISUAL BORROWING POLICY

The Energy Economic Education Office has an energy audiovisual library available for free loan to Nebraska educators.

So that we may accommodate as many educational users as possible, the following conditions will apply to all borrowers.

1. Items may be kept for viewing for one week only before returning it to the Energy Economic Education Office, and

2. Borrower will pay return postage for the audiovisuals and will be responsible for the materials until it is returned.

TEACHING UNITS IN ECONOMICS AND ENERGY

Master Curriculum Guide in Economics: Teaching Strategies for High School Economic Courses. 1985. John S. Morton, Stephen Buckles, Steven Miller, David M. Nelson, and Edward C. Prehn. Features a sample outline of a one-semester high school economics course as well as 22 lessons designed to complement and extend textbook assignments and classroom lectures. Also contains an economics glossary, suggestions for using the lessons to give students practice in applying a decision-making process to economics issues, guidelines for selecting teaching materials, and practical advice on how to evaluate student progress. 192 pages. $14.95

Master Curriculum Guide in Economics: A Framework for Teaching the Basic Concepts (2nd Edition). 1984. Phillip Saunders, G.L. Bach, James D. Calderwood, and W. Lee Hansen. A highly readable presentation of the content and method of economics. This guide is especially good background reading material for teachers without training in economics. 71 pages. $8.00

The Economics of Energy: A Teaching Kit (Grades 7-12). 1983. Joint Council on Economic Education, 432 Park Avenue South, New York, NY 10016. Teaching kit on the economics of energy with a detailed economic analysis of recent conditions and 11 lessons. This kit may be of use to those teachers who want to extend the materials in the present curriculum unit. 103 pages. $2.50

Energy and Economics: A Curriculum Unit for Jr. and Sr. High Schools, Nebraska Center on Economic Education and the Nebraska Energy Office. Lesson plans that incorporate such economics concepts of supply, demand, equilibrium, scarcity, and cartels in the energy marketplace. It contains worksheets and simulation games with teacher background material to help teach the interrelationships between energy and economics.

ADDITIONAL SOURCES FOR ENERGY INFORMATION

National Energy Foundation, Curriculum Coordinator, 5160 Wiley Post Way, Suite 200, Salt Lake City, UT 84116.
Your local utility company (Public Power District, Electric Company, Gas Company).
Innovative Communications. 2923 N. Main Street, Walnut Creek, CA 94556.
National Science Teachers Association, 1742 Connecticut Avenue, N.W. Washington, DC 20009.
Amoco Educational Services, PO Box 5910-A, Chicago, IL 60680.
Phi Delta Kappa, PO Box 789, Bloomington, IN 47402.
American Petroleum Institute; Publications and Distribution Section, 2101 "L" Street, NW, Washington, DC 20037.
League of Women Voters, 1730 "M" Street, NW, Washington, DC 20036.
Congressional Quarterly, Inc., 1414 22nd Street, NW, Washington, DC 20037.
Public Affairs Department, Exxon Corporation, 1251 Avenue of the Americas, New York, NY 10020.
Union Oil Company of California, Corporate Communications, Department A, PO Box 7600, Los Angeles, CA 90051.
Lincoln Electric System, 1200 "N" Street, Suite 300, Lincoln, NE 68508.
American Gas Association, Educational Programs, 1515 Wilson Boulevard, Arlington, VA 22209.
Sierra Club, Information Services, 530 Bush Street, San Francisco, CA 94108.
The NEED Project, PO Box 2518, Reston, VA 22090.
Edison Electric Institute, 1111 19th Street, NW, Washington, DC 20036.
Electric Power Research Institute, Inc., Communications Division, PO Box 10412, Palo Alto, CA 94303.
Resources for the Future, Inc., 1755 Massachusetts Avenue, NW, Washington, DC 20036.
National Geographic Society, Educational Services, Department 82, Washington, DC 20016.

ENERGY INFORMATION REQUEST FORM

Mail to:
JoAnn S. McManus
Office of Energy and Economic Education
307 College of Business Administration
University of Nebraska-Lincoln
Lincoln, NE 68588-0402

NAME ____

ADDRESS OF SCHOOL/ORGANIZATION ______________________________

______________________________ PHONE ______________________

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Please schedule the following audiovisual(s):
Please specify type (16mm, 1/2" or 3/4" video cassette).

Title	Requested Date	Alternative Date

Other comments or questions:

This material was prepared with the support of funds returned to the Nebraska Energy Office on behalf of Nebraska consumers by court order to effect restitution for oil overcharges by the Exxon Corporation and administered through programs authorized under the U.S. Department of Energy (DOE) Grant No. De-FG47-80CS69109 EES or DE-FG47-80CS62029 SECP. However, any opinions, findings, conclusions or recommendations expressed herein are those of the authors and do not necessarily reflect the views of DOE or the Nebraska Energy Office.